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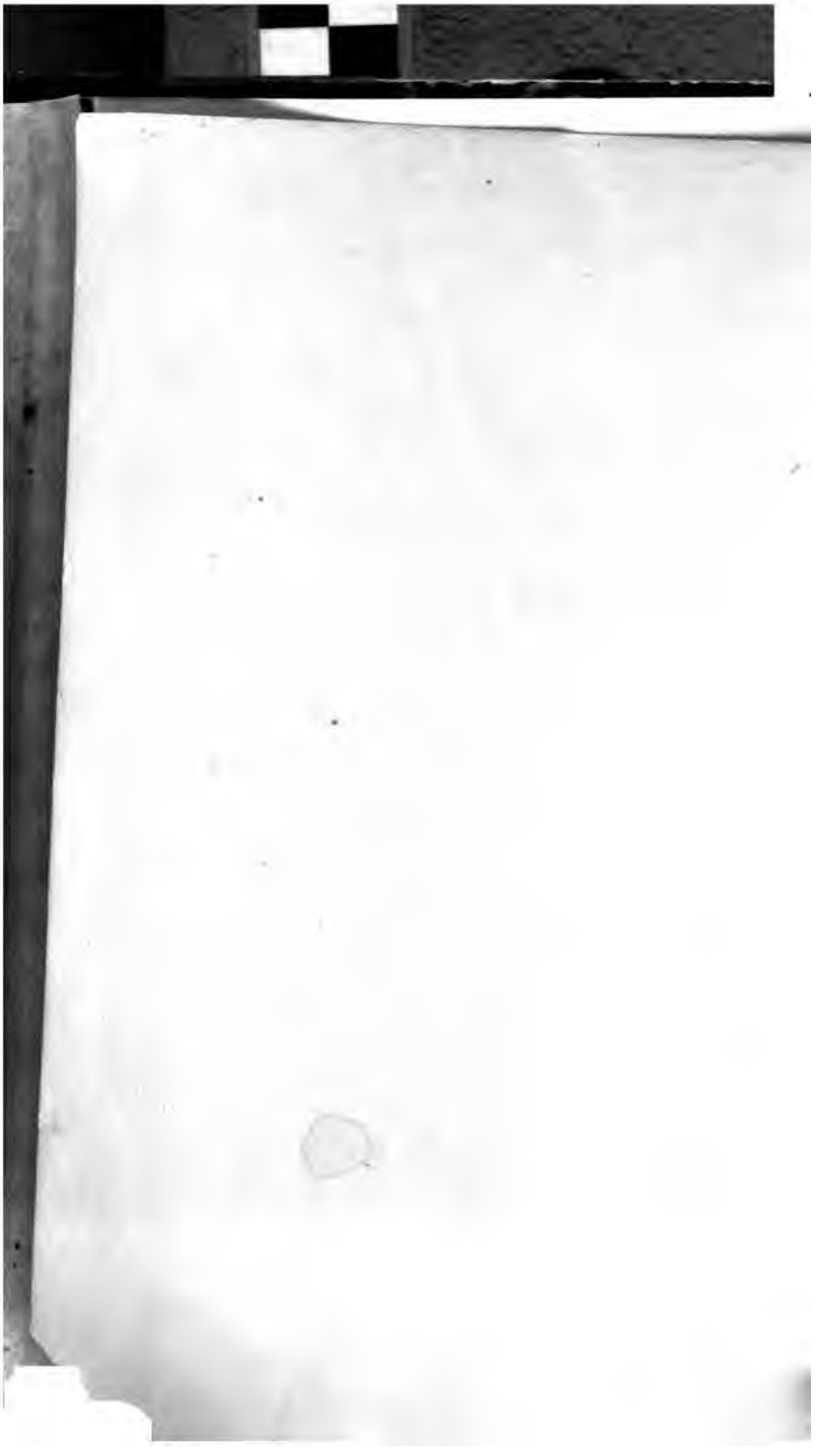

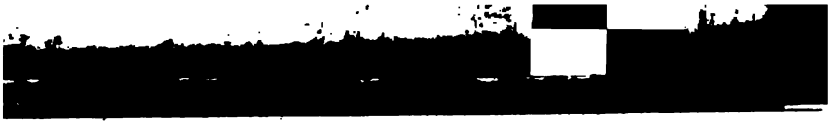

ROCKY MOUNTAIN

HEALTH RESORTS.

AN ANALYTICAL STUDY OF

HIGH ALTITUDES

IN RELATION TO THE

ARREST OF CHRONIC PULMONARY DISEASE.

BY

CHARLES DENISON, A. M., M. D.

REPORTER TO THE INTERNATIONAL MEDICAL CONGRESS, PHILADELPHIA, 1876, ON "THE INFLUENCE OF HIGH ALTITUDES UPON THE PROGRESS OF PHTHISIS"; AUTHOR OF "REPORTS ON CLIMATE AND CONSUMPTION" TO THE AMERICAN MEDICAL ASSOCIATION, ETC.

SECOND EDITION.

"The empire of climate is the most powerful of all empires."
MONTESQUIEU.

BOSTON:
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To

PROF. JOHN T. METCALFE,

OF NEW YORK,

IN RECOGNITION OF HIS DISTINGUISHED ABILITY AS A PHYSICIAN

AND GENUINE FRIENDSHIP FOR THE AUTHOR,

AND TO

DRS. H. C. LOMBARD,

OF GENEVA,

AND

D. JOURDANET,

OF PARIS,

IN CONSIDERATION OF THEIR NOTED LABORS IN THE SAME FIELD,

THE AUTHOR TAKES PLEASURE IN DEDICATING

This Volume.

PREFACE TO THE SECOND EDITION.

It is rather soon after the first issue of this work, to draw definite conclusions as to its results. However, I am pleased to find that those invalids, who have directly or indirectly been led thereby to try the Colorado climate, were better suited to the change they were making than those who came on their own responsibility or hearsay reports. This result is a gratifying proof of the soundness of the conclusions given. I am encouraged also by the generally favorable reviews of this work, and believe more firmly than ever that, though the book has many faults, it supplies a positive need of the present, and may be in the future an incentive for some one else to elaborate the conclusions given.

It was my desire to furnish some conclusive evidence of the superior advantages these inland elevated sections have for certains classes of chronic pulmonary diseases, and to lessen the uncertainty naturally surrounding a subject so complex in all its phases. I disliked to assume the responsibility of urging those with the most doubtful or advanced diseased conditions to try the experiment of high altitudes, therefore the *results of experience* were allowed to speak as plainly as possible against it as a hazardous measure.

It must be remembered, however, that, independent of the stage or phase of the disease, the average experience of consumptives is largely influenced by extreme conditions both favorable and unfavorable. These modifying extremes must be taken into account to rightly estimate the average experience this book contains. For instance, the most favorable cases have some unused respiratory power, a certain elasticity of pulmonary tissue, the capability and aptitude for out-door exercise, and a hopeful and contented state of mind; while an unfortunate make-up for any decided change of climate whatever is the chronic grumbler whom nothing can please, who has no excuse for ordinary weather changes, who has little or no reserve lung space and is physically incapacitated from doing anything for himself, yet is compelled to exist through his own resources, and whose mind is never free from the thought of his own ailment. Those of the latter class continue to surround this subject of climatic change with uncertainty and distrust, while those of the former class are very uniformly bearing testimony of the wonderfully curative results of time spent in the western wilds.

The sincere wish of the author is that this little volume may help to establish the discrimination and foreknowledge which leads to success in the journeyings of invalids to Colorado.

It is evident that, previous to a journey to these elevated plateaus, some more thorough investigation and understanding between physicians is needed in critical and uncertain cases. As fulfilling this requirement and furnishing a means of correspondence between distantly

located physicians, comprehensive and definite enough to be akin to a personal interview between them, I have devised a "Chest Examination Chart" by means of which diseased conditions may be easily and graphically represented, and which I will willingly send to any professional brother wishing it.

DENVER, COLORADO, *November* 1, 1880.

PREFACE.

THE question of climate is one which has of late years attracted the universal attention of the medical profession. So much has already been said and written upon this subject, so many diverse opinions have been expressed, and so many learned treatises by authors of unquestioned ability and repute, representing different sections of the globe, have been published, that it might seem to savor of temerity on the part of him who undertakes anything of a like character.

Despite all research, however, differences of judgment still obtain, and the only hope of harmonizing these diverse conclusions seems to be by a more minute study than has yet been undertaken, of the qualities which make up what we term climate.

The importance of this is seen when the question is asked as between warm and cold, wet and dry climates, and high and low regions, — how do the ingredients of the atmosphere change under these varying conditions, and what are the positive or varying effects? My personal and professional experience in the peculiar climate of this Rocky Mountain region has probably induced medical friends to present a claim upon me to give them the result of the observed effect of this climate upon pul-

monary disease in its various forms. It is on account of this demand, and in the hope of throwing some additional light upon this interesting subject, that I essay to enter a field where it would be almost a presumption to appear without such encouragement.

In presenting this imperfect treatise to the public, I deem it essential to make an explanation as to its purpose, lest the work be subjected to unjust criticism, through a misconception of its complex objects.

It may seem a mistake to attempt a work, which it is hoped, on the one hand, may be worthy a place in the physician's library, and on the other, become, to a certain extent, a guide to the invalid, who, at least is, equally with the physician, interested in the question of climatic relief. Here it should be observed that I use the term invalid in a comprehensive sense, embracing those strongly predisposed to disease as well as those already affected.

In such a discussion two considerations present themselves. First, the growing demand of invalids themselves for a knowledge of climatic conditions and the benefits which may be reliably anticipated from a change of climate; and, second, the desire of the profession for the results of scientific observation as to the effect of high altitudes upon pulmonary disease in its various stages of progress, and for reliable data upon which the physician may predicate an opinion, in directing the future course of his patient.

It is no longer a secret among medical men, that the ordinary therapeutic remedies are of little avail, compared with change of climate, in arresting this disease;

and, further, the great majority of the profession are not so located as to make it possible for them to study and personally observe remedial climatic influences. The foregoing will serve as an explanation to the profession for the dual character or purpose of this work. Moreover, obviously, in such an undertaking, facts and conclusions should be briefly and concisely stated, and, as far as possible, in terms easily comprehended by the lay reader. The physician is therefore asked to overlook the somewhat heterogeneous character of the topics referred to, and the popular tone of the work as a whole; while the non-professional reader's indulgence is claimed for the occasional necessary use of purely professional terms.

Because several rehashes, so to speak, of the author's report on "The Influence of High Altitudes on the Progress of Phthisis," to the International Medical Congress, in 1876, have since been made by those who were not generous enough to credit the source of both the material and method of their essays, I am compelled to notice this fact in explanation to those who have not seen that report, for any seeming plagiarism in these pages, because both the argument in favor of an *ideal* climate, the method of analysis, etc., there used, constitute in some part the structure of this work. The purpose of that Report (and this fuller presentation of the subject was then in mind) was to seek, through the aid of thorough investigation and study of the *attributes of climate*, the generally most successful *climatic home* for the victims of chronic pulmonary disease. This *ideal* climate for the consumptive is a subject of sufficient

scope for present study. In the analysis of its attributes and in the experience of invalids, affirmative evidence of the following pertinent proposition is presented: *The adaptation of climate to the special requirements of chronic pulmonary disease, results in the prolongation of life if not in the eradication of the pulmonary affection.*

CHARLES DENISON.

DENVER, COLORADO, *October* 16, 1879.

CONTENTS.

INTRODUCTION.

PAGE

CONSUMPTION AND ITS PREVALENCE 1

CHAPTER I.

CLIMATES OF LOW ELEVATIONS.

European Experience. — Improved Digestion a False Guide to the Best Climate. — Dryness is essential. — Low, Moist Climates. — Low, Sedative Climates. — Low, Stimulating Climates. — In England. — Italy. — The Riviera. — Marine Climates. — American Resorts at Low Elevations 8

CHAPTER II.

MEDIUM ALTITUDES.

Minnesota. — Asheville. — Walden's Ridge. — Southwestern Texas. — Western Kansas. — Mesilla Valley. — Brazil. — Görbersdorf. — Mont Doré. — Eaux Bonnes. — Other Resorts 14

CHAPTER III.

HIGH ALTITUDES.

Alpine Resorts. — St. Moritz. — Davos. — Asiatic Health Stations. — Altitudes in South America. — The Anahuac. — Colorado. — Divides. — Trees. — Parks. — Rocky Mountain Scenery 18

CHAPTER IV.

CLIMATIC MAP OF THE EASTERN SLOPE OF THE ROCKY MOUNTAINS.

Directions. — Isothermal Lines. — Hypsometrical Plats. — Rain Gauge Lines. — Winds, Prevalence and Directions. — Meteorological Data. 26

CHAPTER V.

MINERAL SPRINGS AND OTHER HEALTH STATIONS.

Middle Park. — Idaho. — Springdale. — Boulder. — Estes Park. — Morrison. — Natural Monuments. — South Park. — Manitou. — Canon City. — Puncha Pass. — Liberty Hot Springs. — Antelope Park. — Pagosa Springs. — Other Resorts in Southwestern Colorado.— Ojo Caliente. — Las Vegas. — Trinidad. — Pueblo. — Colorado Springs. — Denver 29

CHAPTER VI.

ANALYSIS OF THE ATTRIBUTES OF HIGH ALTITUDE CLIMATES.

Consideration of Altitude in the Abstract. — Professional Theories as to Resorts. — Temperature 51

CHAPTER VII.

HUMIDITY.

Relative and Real Humidity. — Absolute Humidity the Criterion. — The Air holds Moisture according to Temperature. — Comparison of Climates. — The Kirgheez Steppes. — Astrachan. — Cool, Dry Climates 60

CHAPTER VIII.

DIATHERMANCY OF THE AIR.

Clearness of the Air in Colorado. — Tables showing Diathermancy. — Table showing Difference in Elevation for each Degree of Diathermancy. — Effect upon Radiation. — Beneficial Effects of Sunshine increased with Altitude. — Therapeutic Value of Light and Sunshine 68

CHAPTER IX.

ATMOSPHERIC ELECTRICITY. — OZONE AND WINDS.

Curative Influence of Atmospheric Electricity. — Civilization trammels Physical Development. — An Out-door Life. — Sleeping on the Ground. — Electricity of High Altitudes. — Ozone. — Imperfection of Schönbein's Test. — Ozone on the Heights. — Ozone among the Pines. — Efficacy of Ozonized Air. — Winds . . 74

CHAPTER X.

ALTITUDE.

Physiological Effects of High Altitudes. — The Pulse affected by Elevation. — By Exercise. — Respiration affected by Elevation. — Jourdanet's Theory. — More perfect Oxygenation on the Heights. — M. Paul Bert's Experiments. — Anæmia. — Deeper and more Frequent Respirations. — The Endosmose of Oxygen favored . 81

CHAPTER XI.

ALTITUDE OF APPROXIMATE IMMUNITY FROM CONSUMPTION.

The Theory of an Exact Line of Immunity. — No general Positive Rule. — The Altitude of Approximate Immunity in Europe. — In North America. — In South America. — In Mexico. — Altitude of Immunity in Colorado. — Cases above Six Thousand Feet. — Below that Altitude. — Effect of Progressive Civilization . . . 95

CHAPTER XII.

ASTHMA, ETC.

The Ideal Climate corroborated by Experience. — The Rarefied Air Cure of Asthma in the Rocky Mountains and Plains. — Definitions. — Theories. — Experiences. — Emphysema 103

CHAPTER XIII.

THE RESULTS OF THE CLIMATIC TREATMENT OF CONSUMPTION IN COLORADO.

Three Hundred and Fifty Years spent by Two Hundred and Two Consumptives in the Rocky Mountain Region. — Character of Cases. — Analysis as to Stages of Disease. — Results. — Both Lungs affected. — Sex. — Nature of Disease, Analysis, and Conclusions. — Partial Recovery necessitates Permanent Residence. — Pulse, Respiration, and Temperature of Favorable and Unfavorable Cases. — Analysis as to Age, Comparisons, and Conclusions 114

CHAPTER XIV.

PULMONARY HEMORRHAGE.

Hemorrhagic Cases. — Are they suited to the High Altitude Treatment? — Table of Results, with Analysis and Conclusions. — Illustrations 134

CHAPTER XV.

COMPLICATIONS AND CONCLUSIONS.

Bronchitis. — Illustrations. — Pleurisy. — Nervous and Rheumatic Complications. — General Conclusions 143

CHAPTER XVI.

PRECAUTIONARY MEASURES.

Pulmonary Gymnastics. — Health Lift. — Morning Exercise. — Cold Water. — Daily Gymnastics. — Exercise *vs.* Inaction. — Prevention of Consumption. — Value of Ranche Life 154

CHAPTER XVII.

CAMPING OUT.

Hints for Invalids. — Elevation with Discretion. — Camping Out. — Sunlight. — Sunsets. — Camp Scenes. — Results. — Flowers of Colorado. — "Outfit." — Clothing. — Bedding. — How to Camp Out with Little Expense. — Camping Parties. — Estimates. — Routes of Travel 161

ROCKY MOUNTAIN HEALTH RESORTS.

INTRODUCTION.

CONSUMPTION AND ITS PREVALENCE.

It is mainly for the purpose of starting aright with the non-professional reader that I, in the first place, superficially refer to the various abnormal conditions classed as *consumption*, with which our subject, *climate*, has chiefly to do. Afterward, I go more fully into the question of its *prevalence*, as furnishing to all, abundant evidence of the need of thorough investigation of the question of climatic relief.

I purposely avoid entering the broad field of the pathology of this disease. It would be an unwarrantable digression from the object of this work to attempt here a histological treatise of this intricate theme, even if I were able to do the subject justice.

The general acceptation of the term *Consumption*, or *Phthisis*,[1] is so broad in its significance that a certain degree of latitude for misconception must be conceded, when peculiar phases of the disease are under consideration.

When the question presents itself, *What is Consumption?* it becomes difficult to give a specific definition of the term, on account of the uncertainty as to whether it represents a local affection, *ab initio*, or whether it

[1] Throughout this work these terms are used synonymously.

indicates some dyscrasia, or abnormal blood-state, which may precede or accompany its development.

Without specifying pathological conditions, we may aptly, though perhaps superficially, speak of Pulmonary Phthisis as *slow death commencing in the lungs;* as Dr. James Henry Bennett tersely expresses it, "simply a mode of dying." In other words, consumption is a wasting and decay, the seat of the affection being generally pulmonary. Or, we may approximate the truth by saying it springs from a depreciated state of the blood, associated with some inactivity of the lungs.

For the purpose of noting its prevalence, we may understand consumption as including nearly all such lung affections as are destructive in their tendency, "generally chronic and attended with cough and emaciation,"[1] not even excluding conditions, which others might term *symptoms* of the disease, such as chronic cough, spitting of blood, hemorrhage from the lungs, etc.[2] With this broad classification, we find that the ratio of deaths from this disease, among the adult population, is so startling as to force the conclusion that it is one of the most important subjects which can be brought to the consideration of a thinking public. Our interest is particularly centred in the ratio of deaths from pulmonary disease among adults, as it is among them that the mortality mainly occurs. Allowing for the mortality in youth and childhood, which covers nearly half of all the deaths, the ratio of deaths from consumption among adults is

[1] Dr. Hermann Weber, in the *Medico-Chirurgical Trans.*, vol. iii., "Treatment of Phthisis by Prolonged Residence in Elevated Regions," gives the credit of first promulgating these views to the late Dr. Thomas Addison, "whose teaching that inflammation constitutes the great instrument of destruction in every form of phthisis was for a long time ignored, or regarded as erroneous, by most of his contemporaries."

[2] For general purposes it is nearly the same whether the consumption be qualified as bronchial, pneumonic, hæmorrhagic, laryngeal, chronic tuberculous, etc.

nearly doubled. This reckoning adds weight to the significant fact that, according to the last census, about fourteen per cent. of all deaths in the United States are from consumption, while in some considerable districts (as the New England States, New Brunswick, Nova Scotia, Newfoundland, and Canada), densely populated cities (as New York), and low countries bordering upon rivers, it is over twenty per cent. of the total mortality.

It is estimated that of every ten thousand persons in the United States thirty-five die annually of consumption. According to Lombard,[1] the mortality from this disease is twelve per cent. in England and Scotland, and eleven per cent. in France; while during the years 1858 and 1859 it amounted to nearly *one fifth* of the mortality from all causes in Russia; and in the English army in garrison the mortality reaches the extraordinary proportion of forty-six per cent.

These observations are in accord with the testimony of the distinguished Niemeyer,[2] who vouches for the truth of the assertion that "in nearly half of all cadavers we find traces of the nutritive disorders from which pulmonary consumption proceeds."

The following tables are compiled chiefly from the experience of life insurance companies, and serve to illustrate the prevalence of this disease, in a manner especially pertinent to our present discussion. For the general reader these evidences are emphasized by the consideration, that so great ratios obtain, notwithstanding the scrutiny practiced by officials against the insurance of consumptives.

[1] *Traité de Climatologie Medicale*, par Dr. H. C. Lombard, tome ii.
[2] *Text-Book of Practical Medicine*, vol. i.

TABLE I.

SHOWING THE MORTALITY BY CONSUMPTION AMONG ONE THOUSAND DEATHS OF THE INSURED, IN SEPARATE GROUPS OF STATES.

Compiled from the experience of some thirty American Life Insurance Companies.[1]

1. New England States and New York 197
2. Michigan, Wisconsin, Minnesota, Nebraska 173
3. New Jersey, Pennsylvania 207
4. Ohio, Indiana, Illinois, Iowa, Kansas 177
5. Delaware, Maryland, Dist. Columbia, Virginia, Kentucky, Missouri 164
6. South of 36° 30′, North Carolina, South Carolina, Tennessee, Georgia, Florida, Alabama, Michigan, Arkansas, Louisiana, Texas 123
7. Washington, Oregon, California, Utah, Dakota, New Mexico . 151

Average 183

This table serves principally to show the distribution of this disease throughout the United States. It may also be considered as showing the prevalence of the disease among a class of adults previously selected as not liable to it.

TABLE II.

SHOWING THE NUMBER OF DEATHS FROM CONSUMPTION FOR EACH GROUP OF TEN YEARS IN THE EXPERIENCE OF TWO LIFE INSURANCE COMPANIES.

Age at Death in Decennial Periods.	Number Dying from Consumption	
	National Life Insurance Company (ten years' Experience).	Mutual Life Insurance Company of New York.[2]
20 to 29 years	28[3]	181
30 to 39 years	55	401
40 to 49 years	29	296
50 to 59 years	18	113
60 to 69 years	5	33
70 to 79 years	–	7
Total	135	1,031

[1] The whole number of deaths by consumption being 6,474. By favor of the compiler, Mr. Levi W. Meech, Norwich, Conn.

[2] Taken, as well as much of the three following tables, from the annual Mortuary Report, 1877.

[3] Computed 18 to 25 years.

Estimating each policy at $2,000, which is about the average, here is the startling fact that these companies have paid out over $2,000,000 in losses by this disease alone; an amount which represents nearly one fifth of all their losses sustained by death.

TABLE III.

SHOWING THE MORTALITY FROM CONSUMPTION IN THE ADULT MALE POPULATION OF THE UNITED STATES, ARRANGED IN DECENNIAL PERIODS OF LIFE FROM THE U. S. CENSUS, 1870.

Age in Decennial Periods.	Male Population of the United States.	Annual Number of Deaths from Consumption.	Annual Number of Deaths from Consumption in 10,000 Living.
20 to 29 years	3,351,617	7,842	23
30 to 39 years	2,452,999	6,591	27
40 to 49 years	1,829,599	5,054	27
50 to 59 years	1,209,855	3,787	31
60 to 69 years	658,153	3,042	46
70 to 79 years	259,318	1,863	71
80 to 89 years	60,042	664	111

We have here more extensive, though less accurately tabulated results, drawn from the ravages of consumption among the adult male population of the United States.

Taking into consideration the many inaccuracies in these national statistics, — due to the exclusion of women and children, and not including many deaths fairly to be attributed to this cause, — we are justified in assuming that nearly 100,000 deaths annually occur in the United States by this disease.

While this table shows that the proportion of deaths from consumption, to the living population, increases with age, — so that no period of adult life would seem to be exempt, — yet it conveys the idea, which is in consonance with the theory of the prolongation of consumptives' lives, that in many cases the disease, commencing

in earlier and more susceptible years, terminated at the later periods mentioned.[1]

It is to be hoped that, by a more intelligent employment of climatic advantages this feature of *delayed* death from consumption may become more marked with each decennial record of mortality. As with many it has to be admitted, "What cannot be cured, must be endured," although death from consumption may eventually ensue, it will have been delayed, and life prolonged by a timely and judicious change of climate and mode of life.

TABLE IV.

SHOWING THE ANNUAL NUMBER OF DEATHS FROM ALL CAUSES AND FROM CONSUMPTION, IN NEW YORK CITY AND IN THE MUTUAL LIFE INSURANCE COMPANY, CALCULATED FOR 10,000 LIVING AT EACH DECENNIAL PERIOD OF LIFE.

Age in Decennial Periods.	Annual Number of Deaths among 10,000 Living at each Age.			
	From all Causes.		From Consumption.	
	New York.	Mutual Life.	New York.	Mutual Life.
20 to 29 years	170	62	70	24
30 to 39 years	197	72	71	20
40 to 49 years	231	87	66	17
50 to 59 years	351	139	84	14
60 to 69 years	589	299	110	18
70 and upwards	1,430	699	150	30

This table enables us to compute a ratio of forty per cent. of deaths from consumption to all causes in New York, between the ages of twenty and forty, while the experience of the Mutual Life Insurance Company gives

[1] Dr. James Henry Bennett tells us that in the lungs of many women in the dead room of the Salpêtrière, a large asylum hospital in Paris, he found evidences which proved, undeniably, that they had been consumptive at some antecedent period of their life, but had died at last of other disease. — *Treatment of Pulmonary Consumption by Hygiene, Climate, and Medicine.*

thirty-three per cent. for the same period. This is an appalling statement, although the proportion is not equal to the record of the State of Maine, where according to the United States Census of 1870, about fifty per cent. of all deaths occurring between the ages of twenty and forty are from consumption.

The early mortality from consumption is better shown, and a greater prevalence indicated by the following: —

TABLE V.

SHOWING THE PERCENTAGE OF DEATHS BY CONSUMPTION OF THE TOTAL MORTALITY FROM ALL CAUSES, FOR EACH DECENNIAL PERIOD OF ADULT LIFE.

Age.	New York City.	National Life.	Mutual Life of New York.	Population of Scotland.	Ten Life Assurance Companies of Scotland
20 to 29 years .	40.84	32.9	37.09	47.20	33.60
30 to 39 years .	35.13	26.6	28.06	33.65	24.10
40 to 49 years .	28.46	15.2	19.62	22.40	13.60
50 to 59 years .	23.99	12.7	10.27	14.50	7.40
60 to 69 years .	18.57	10	6.10	6.45	2.30
70 to 79 years .	12.72	–	5.51	1.70	.65
80 to 89 years .	5.56	–	–	.35	.35

These figures cannot but force upon the reader a conviction that if he is to die short of advanced age, the chances are greatly in favor of death in his case being caused by this consumer of mankind.

Further, if these deaths could be avoided or delayed by precautionary or remedial changes of climate and manner of living, *as up to a certain stage is possible in almost every case*, there would then be a much larger proportion of adults who would reach the ripe age of sixty, and the average longevity would thereby be proportionately increased.[1]

[1] When we consider only the selected short lives, — because of their probable death by consumption, — the question of prolongation of life is presented in its strongest light. It is for this class, *who may be helped*, these conclusions are especially intended.

CHAPTER I.

CLIMATES OF LOW ELEVATIONS.

EUROPEAN EXPERIENCE. — IMPROVED DIGESTION A FALSE GUIDE TO THE BEST CLIMATE. — DRYNESS IS ESSENTIAL. — LOW, MOIST CLIMATES. — LOW, SEDATIVE CLIMATES. — LOW, STIMULATING CLIMATES. — IN ENGLAND. — ITALY. — THE RIVIERA. — MARINE CLIMATES. — AMERICAN RESORTS AT LOW ELEVATIONS.

IN considering the climatic treatment of Phthisis, it is not necessary to dwell upon the limited experience in this particular of our medical fathers. The conclusions of Dr. Walshe, that "climate takes its occasional share in bringing about the nearest approximations to real cure therapeutically obtainable,"[1] is now very generally held by medical men. While the failure of medicine to cure or check it has been slowly realized, still the benefit derived from even slight changes of climate must have suggested a climatic cure. The evidences of the therapeutic value of high altitudes are, however, comparatively recent.

It is not strange, then, that with no better experience as a guide, the medical profession, influenced by the occasional successes of Mediterranean, low continental, maritime, and English health resorts, has hitherto placed confidence in them.

In England and on the continent, the work of describing and classifying favored health resorts has been brought to a state of perfection unattained elsewhere; and, as will be seen, this analytical method has resulted in a better appreciation of the question of elevation among European scientists, than has obtained in our

[1] *Diseases of the Lungs*, W. H. Walshe, M. D., London.

own country. But it is a question in my mind if these analyses are not sometimes made with the exclusion of important data, — notably the moisture of the air, — while undue importance is given to less vital points, such as the precise degree of temperature and the daily variation.

Yet the authors of these works so often feel it incumbent upon themselves to tell one how to get away from a resort, if he is not suited, that frequently no relief seems to be expected; while the invalid, victim of these doubts, ekes out a six months' absence in a trial of as many separate resorts. This guessing an answer to the invalid's conundrum, "*Where can I best find relief?*" is far from the certainty and confidence which should characterize the climatic treatment of consumption.

After studying the description of the numerous low, inland, and Mediterranean resorts,[1] where all the phases and symptoms of consumption are so nicely met by climatic prescriptions, one naturally disbelieves the conclusions given, based as they are upon acknowledged theoretical grounds, not sufficiently warranted by experience.

The inquiry naturally presents itself: What certainty have consumptives of obtaining permanent relief in low, humid climates? It is premised that, if in these low and narrow limits favorable qualities are found, then efficiency in the climatic treatment of phthisis demands more decided proportions of the same qualities. It will be shown that these are to be found, together with additional advantages, at *suitable* elevations.

In Europe, a reason has seemed to exist for sending to the warm shores of Italy or the South of France, and

[1] In grouping reputed climates for this cursory study, no attempt will be made to mention all that have obtained a certain degree of celebrity; the principal ones, which may serve as types of a class, being sufficient for illustration.

with us, to Florida, those consumptives with feeble stomachs, who are unable to digest the quantity of food necessary to supply the waste caused by the greater amount of oxygen inspired in the colder regions of the North. In warm, moist climates, less carbonic acid is given off, and less heat required, so that a feeble digestion is not so heavily taxed as in severer climes. This plan works well, as a palliative measure; but as warm weather approaches, it is reasonable to suppose that the scales will be turned, and the enervation and accompanying indigestion, experienced at the South, will be much relieved by a return to the cool climate of the North. So consumptives, who have shunned a harsh New England spring by a sojourn in Florida, hasten back with returning summer to cool seaside and country resorts, and, with indifferent benefit, are kept continually upon the move.

This idea of allowing the digestive capacity to decide to what climate a consumptive should go may often seem to result in good, but it is founded upon uncertain premises and lacks much desired definiteness in results. Like most of the theorizing as to the treatment of consumption, indulged in by authors for many years, it is not radical enough to answer our purpose.

As I shall speak positively in favor of the benefit of high altitudes, where not specially contra-indicated, and hope the reader will concur with me in this favorable opinion, I mention here the reasons we have for less confidence in low climates. It will be seen, when we come to discuss the humidity of the air, important data, in regard to the undesirability of low climates, are lacking. We have few records of the relative or absolute humidity of these places in Europe; and as humidity, or rather the lack of it, is one of the essential criteria by which we judge of our ideal climate, this becomes an important consideration. They all represent climates more or less moist.

Of climates in England, Dr. C. T. Williams[1] gives valuable statistics of several localities, mainly along the southern shore of the island, and comments upon the favorable results of 386 winters spent at those places by 243 consumptives. "Bear in mind," he says, "that these general results assign the largest amount of benefit to the most easterly stations, and follow a course exactly the reverse to that of the warmth of the localities, Hastings, the coldest, being at the top of the list, and Torquay, the warmest, being at the bottom," Ventnor and Bournemouth being between these. This result will be claimed as an argument for high altitudes, when we consider that a cooler temperature, as well as less humidity, are the characteristics of great elevations.

On the continent also are warm, moist climates, called *sedative*. We have types of this group in Pau, remarkable for the *stillness* of its climate, where, as we are informed, a plentiful amount of rain "falls perpendicularly;"[2] Valencia in Spain, which Dr. Walshe characterizes as "probably one of the warmest, most humid and depressing spots in continental Europe;" Pisa, a once populous city in Italy, which, the same author says, "has completely lost its *quondam* prestige as a sanitarium," though, as we fail to notice positive climatic qualities to recommend it, we are surprised at the further assertion that "this changed opinion is the result of sheer medical caprice;" Venice, where, according to Dr. Rohden, of Lippsprings, the advantages are "counteracted by the uniformity and everlasting level of its walks, bad water, and abundant rain;" and Rome, which Dr. Williams[3] represents as having formerly "great repute, though for many years its unfitness as a shelter for invalids has been recognized, and it is now mainly resorted to for pleasure and not for health."

[1] *Lettsomian Lectures, On the Influence of Climate in the Treatment of Pulmonary Consumption*, by C. T. Williams, M. D.

[2] C. T. Williams, *op. cit.* [3] *Op. cit.*

There are also more exhilarating resorts termed *stimulating*, though at a low elevation, which, like Hastings in England, partake of the best qualities of high altitudes, and show, according to Dr. C. T. Williams's excellent tables, a proportionate improvement in consumptives, for the winters spent there. Of this class, we have Hyères, Cannes, San Remo, Nice, and Mentone, representing the Riviera, which are rendered comparatively *dry* by the prevalence of land-breezes; Barcelona, Gibraltar, Malta, Algiers, and Malaga. All of these resorts are notably less moist than the sedative group, and have some peculiar advantages; for instance: Dr. Edwin Lee says of Naples, "The frequent variations from dryness to moisture, and from warmth to coldness, promote the disengagement of electricity."

I believe the *marine* climates, being wholly surrounded by salt water, confer some of the advantages of sea-voyages, in that the air is constantly in motion, and the insensible activity of the skin thereby promoted, while the atmosphere is always pure and bracing. Therefore these may be considered better than moist climates on the continent of Europe, and yet Dr. Walshe says of Madeira, "Much of this promising character turns out to be practically delusive. The damp is so extreme that changes of temperature thermometrically small — of three or four degrees — prove sensationally great; a temperature of 58°[1] in-doors, without being actually cold, is disagreeably chilly." The Canary Isles, St. Helena, some of the Mediterranean Islands, the Bermudas, Bahamas, West Indies, etc., may be considered in this group.[2]

There are *relatively* very dry climates, as Egypt and Syria, whose enervating quality is the high temperature,

[1] Fahrenheit scale.

[2] A sea captain of long experience, who now lives in Denver, for the relief of asthma, tells me that he carried many consumptives to the Sandwich Islands, but "*brought none of them away.*"

which would be hardly bearable were the dryness absolute.[1]

Of American climates of low elevations, we have the resorts of moist and sedative Florida; Aiken, South Carolina, with its dry, bracing atmosphere and sandy soil;[2] the balsamic region among the pines in southern Georgia;[3] the dry and alkaline regions of southwestern Texas, in the vicinity of San Antonio; and the exceedingly equable and mild Pacific coast, — San Diego, Santa Barbara, and San José, in California, — which, by reason of the great humidity of the atmosphere, are much like the warm moist climates of the Mediterranean basin. The favored low resorts in the United States might perhaps be better chosen, climatically speaking; the attractions, however, have thus far been where the comforts of life were to be found.

[1] In southwest Arizona, and in the inland portion of southern California, — notably in the vicinities of the Death Valley and Fort Yuma, — the winter months only are comfortable, and sometimes hardly that, because of the intense radiation from the sandy plains. At Fort Yuma, Dr. Geo. S. Rose, of the United States army, has informed me that the mean annual rain fall has been for nineteen years only 2.95 inches, while the average temperature has been remarkably high — about 75°.

[2] *Aiken as a Health Station*, W. H. Geddings, M. D.

[3] *The Pine Forests of Georgia as a Resort for Invalids*, by Ezra R. Pulling, M. D.

CHAPTER II.

MEDIUM ALTITUDES.

MINNESOTA. — ASHEVILLE. — WALDEN'S RIDGE. — SOUTHWESTERN TEXAS. — WESTERN KANSAS. — MESILLA VALLEY. — BRAZIL. — GÖRBERSDORF. — MONT DORÉ. — EAUX BONNES. — OTHER RESORTS.

AMERICA is blessed with advantageous resorts for cases in which high altitude is not well borne, or, rather, not permissible. Especially is this true of *medium altitudes*, though the need of them has yet to be more generally recognized by physicians who guide invalids, before desirable comforts and accommodations will be assured.

Among these should be mentioned St. Paul and Brainerd, as types of Minnesota climate, at an elevation of 1,200 feet; Asheville,[1] North Carolina, where a sanitarium has been established for consumptives, at an elevation of 2,250 feet, the sunny hills of this locality offering ample facilities for the out-door life and *climbing treatment*, which the resident physician, Dr. Gleitsmann, advocates with signal success; also, the Cumberland Table Land, more especially that part of it known as Walden's Ridge.[2] This region lies among the mountains of Eastern Tennessee, about 2,000 feet above the sea. Consumption is almost unknown among the natives, who are so much employed in out-door occupation that they live almost altogether in the open air. Owing to its contiguity to the heated South, it is to be presumed that this may become a favorite resort, when its natural attractions have been improved and rendered accessible by traveling facilities.

[1] *Western North Carolina as a Health Resort*, by W. Gleitsmann, M. D. *The Climatotherapy of Consumption*, by S. E. Chaillé, A. M., M. D.

[2] *A People without Consumption*, E. M. Wight, M. D., Chattanooga.

In the Southwest we find the valley of the Rio Grande, Boerne, Fredericksburg, and Fort Clarke, in Texas, with a medium altitude of 1,500 to 2,000 feet; farther north the climate of Western Kansas, and that of Southeastern Colorado, of which Las Animas, upon the Atchison, Topeka, and Santa Fé Railroad, is the centre. Both of these last mentioned regions are within the area of the *buffalo-grass*, which is a local characteristic of the altitude, beginning at about 3,000 feet elevation and extending west to the mountains.

The Mesilla Valley, in Southern New Mexico, furnishes a type of medium altitudes, and, as a favorable health-station for pulmonary invalids, deserves more than a passing mention. This valley is about seventy miles long, varying from one to six miles in width, and rising from 4,000 feet on the Rio Grande to 7,000 among the foot-hills. The air is soft and agreeable, with a bright sunshine almost every day of the year. The dryness of the air of this region is exemplified by the preservation by desiccation, or "mummification," of the bodies of the dead, exposed in former years upon these southern plains. A similar process has been observed to occur in the deserts of Northern Africa and Southern Asia. "The Mesilla Valley is said to produce a fine variety of grape, with juices heavier than from the grapes of Madeira and Portugal, as the grapes remain on the vine until they commence to dry before being pressed; and the wort contains as much sugar as the sweetest of Malaga. (Brevoort.) When dried they make a good raisin. The almond tree, peach, apple, pear, quince, apricot, are raised there, and all kinds of garden-plants; and probably game is as abundant as elsewhere in the country."[1]

In Mexico we have Cordova, 2,715 feet; Orizaba, 4,030 feet, at the base of the snow-crowned cone of Ori-

[1] *Notes on New Mexico*, Dr. A. L Parlin, U. S. A.

zaba; Jalapa, 4,000 feet, "one of the most beautiful places on earth; its *great* humidity may, however, render it unsuitable to some cases;" and the foot-hills and sunny upland of Chihuahua, sloping northeast toward the Rio Grande.

Dr. Walshe calls attention to San Paulo, in Brazil, at an elevation of 2,300 feet, and a short distance inland from the port of Santos, as a residence for pulmonary invalids, where the air is so dry that "windows and doors are, as a rule, kept open day and night, and the patient may be said practically to live in the open air."

Of European resorts, at medium elevations, we mention the following: —

Görbersdorf, lying in a valley in Silesia, Prussia, at an elevation of 1,700 feet, is the pioneer sanitarium which first introduced into Germany the exercise and open-air method. It opened with twelve patients in 1854, but now numbers six hundred annually.

The village of Mont Doré is situated at an altitude of 3,400 feet, in the most elevated valley of central France. The valley runs north and south, Mount Sancy on the south protecting the inhabitants from the unfavorable south wind, which passes over their heads, while a bracing north wind tempers the solar heat during the summer months. The waters of the springs of this resort are muriated alkaline and are both warm and cold. The atmosphere is clear, dry, and singularly free from dust fumes and organic particles, which render a residence in populous towns so unhealthy.

Königswarth, in Bohemia, lies in a sheltered situation 2,000 feet high. The purity of its atmosphere, its elevation and sheltered position, peculiarly adapt it for climatic cures in anæmia, chronic pneumonic affections, and tendency to consumption.[1] Effervescent chalybeate springs aid the cure.

[1] *Curative Effects of Baths and Waters*, Dr. Julius Braun.

Eaux Bonnes, a French Pyrenean resort, is situated in a narrow ravine, 2,300 feet above sea-level, in the midst of grand natural scenery. This is a very popular resort with the French, who have the greatest faith in its weak sulphuretted, saline springs. Dr. Braun tells us that they attribute the wonderful effect of these waters in lung diseases to some element which they have as yet been unable to discover. "Il y a certainement quelque autre agent qui nous échappe." He adds:[1] "Some of the physicians of the place, however, feel themselves now obliged to attribute the principal effect of Eaux Bonnes, in tuberculous cases, to the high situation of the place."

Aussee, 2,080 feet high, in a sheltered position on hilly ground in Styria, where the sanatarium of Dr. Schreiber is established; Kainzenbad, 2,480 feet high among the Bavarian Alps; Le Prese, sheltered from the north winds in the beautiful valley of the Poschiavino, about 3,000 feet above the sea, one of the most attractive of Swiss resorts; Cauterets, at an elevation of 3,200 feet among the Pyrenees, where it is said men, not to mention broken-winded horses, experience a cure in a week or ten days, "ascribed with great probability, and almost necessarily, to the height of the situation as the active principle;"[2] and the resorts of Lower Engadine, 4,000 feet high, each with its spa and "Kurhaus," are but a few of the many European health stations which might be mentioned as affording climates typical of medium altitudes.

[1] Braun, *op. cit.* [2] *Op. cit.*

CHAPTER III.

HIGH ALTITUDES.

ALPINE RESORTS. — ST. MORITZ. — DAVOS. — ASIATIC HEALTH STATIONS. — ALTITUDES IN SOUTH AMERICA. — THE ANAHUAC. — COLORADO. — DIVIDES. — TREES. — PARKS. — ROCKY MOUNTAIN SCENERY.

COMING now to high altitudes proper, a few places will be touched upon, lying in the region of *an altitude of approximate immunity from consumption*, to be considered farther on in this work. In Europe we have to content ourselves with more unfavorable complications than obtain in the selected high altitudes of America. The Alps present resorts which are high enough for their northern latitude, but are burdened with an excess of moisture gathered by the mountains, which are exposed to the moist Atlantic currents.

Of these Alpine villages, St. Moritz deservedly stands at the head. This resort lies on an elevated incline, 6,000 feet above sea-level, in the Upper Engadine, and is noted, like most other European health-stations, for its spas and *Cure-house*. Its situation upon the banks of the river Inn, the valley of which constitutes the Engadine, is probably not exceeded by any other resort for beauty of scenery, and, despite its harsh air and inclemency,[1] St. Moritz has won a European reputation as a health resort.

There are several other villages in the Upper Engadine, at about the same elevation, — Samaden, Maria, Pontresina, etc., — to which pulmonary invalids resort.

1 Dr. Walshe cites from Dr. Hewlett, that, at St. Moritz, "in fourteen winter months (seven in 1866–7, and seven in 1867–8) there were only fifteen clear days, while 148 rainy days, and others more than half clear with their admixture of snow, sleet, and rain, made up the rest."

Davos, situated among the Alps of Switzerland, at an elevation of 5,200 feet, has attained a reputation which yearly induces hundreds of consumptive invalids, from all parts of Europe, to test the curative influences of its peculiarly pure, dry, and rare atmosphere. The Alpine valley, in which Davos lies, extends, with considerable breadth, for ten miles, northeast and southwest, so that, during the shortest winter day, the sunshine is little obstructed, while the place is protected from chilly winds by mountains of great height at either end.

The *winter air-cure*, for which this resort is particularly noted, embraces the five cold months from November to March, during which time, although the average temperature is twenty-three and a half degrees, Fahrenheit, above zero, the patient is encouraged to sit out of doors in the sunshine, walk, or *climb*, if he can, invigorated by the bracing atmosphere. The reader will notice that, in this case, the extreme cold, which, if it were accompanied by much dampness, would be ordinarily injurious to any one afflicted with pulmonary disease, braces the constitution the more, as it is extremely dry, a given quantity of air at Davos, containing only one third the moisture found in the same volume at Pisa, Italy.[1]

Dr. Vacher gives the number of invalids seeking this resort as eight in 1865, and four hundred in 1874, which shows the increasing favor the results of the treatment have warranted, as well as the comparative newness to Europeans of the special efficacy of high altitudes. I shall have frequent occasion to refer to the experiences furnished by Davos.

In Asia, the elevated plateaus in Persia and Armenia, and those adjoining the lofty Himalaya Mountains, — at Dagshai and Rassanli, sanitaria are established between

[1] *Le Mont Dore-Davos. Étude Médicale et Climatologique sur les Cures d'Air dans la Phthisie Pulmonaire.* Par le Dr. L. Vacher. Paris, 1875.

6,000 and 7,000 feet above sea level, — together with other elevated inland and dry localities, would seem to furnish excellent climatic combinations; but I have not the necessary data for an extended account of that vast section.

In North and South America, the great Rocky Mountain and Andes chain furnish many resorts, of any desired elevation or latitude. In South America, the Cordillera de los Andes, lying close to the Pacific coast, north of the equator, inclose elevated valleys and plateaus from 7,000 to 13,000 feet in height, while snow-clad peaks like Chimborazo, in Ecuador (21,500 feet), and Serato, in Bolivia (22,400 feet), tower above.

The plain of Quito is an Andean ridge, averaging over 9,000 feet elevation, where, in a never-ceasing vegetation and eternal spring-time, the populous city sits enthroned. Here, under the equator, where the seasons over-lap, and seed time and harvest know no end, we may see sowing and reaping going on at the same moment, while herbs and flowers of one kind are at once budding and fading amid all the blended tints of spring and autumn.

In the central portion of Peru, the *Montana* consists of a lofty plateau, averaging 12,000 feet in height, containing many cities and villages, which enjoy a temperate and beautiful climate, with most magnificent scenic surroundings.[1]

In Bolivia the great plain rises to 13,000 feet, in which

[1] When it is considered that, under the equator, the growth of wheat is not established till the altitude of 4,500 feet is reached, and that sugar-cane has been grown at 7,500 and the banana at 5,400 feet, it is not to be wondered at that the most comfortable existence for man is to be found at a considerable elevation, and that populous cities lie high up in the mountains, as Bogota, the capital of the United States of Colombia, 8,650 feet; Quito, of Ecuador, 9,540 feet; Cuzco, the ancient capital of Peru, 11,380 feet; and towns bordering on lake Titicaca, between Bolivia and Peru, 13,000 feet.

Lake Titicaca reposes. We are not surprised that the temperature of Potosi varies greatly throughout the day. "Early in the morning it is cold and piercing; the forenoon is pleasant; from noon till three P. M. it is generally very hot in the sun, while the evenings are usually serene and mild."[1] This city, which once numbered 150,000 inhabitants, lies 13,300 feet above the level of the Pacific.

North of Guatemala the two chains into which the Cordilleras divide inclose the Anahuac, an extensive plateau 6,000 to 8,000 feet above sea level, which, although lying within the tropics, presents a temperate and agreeable climate. Here, in the midst of the most inviting surroundings, lies the antique city of Mexico. It is almost encircled by the lofty Sierras, which inclose beautiful lakes and favored resorts, and send, among other peaks, the Popocatepetl, 17,735 feet above the sea, far into the regions of perpetual snow.

Dr. Jourdanet,[2] a distinguished French physician and scientist, who during a long residence made a close study of the climatic conditions of the Anahuac, speaks very highly of this table-land as a resort well adapted to the cure of pulmonary diseases. He notices, also, another fact, which I have often observed in my own practice, that climatic influences act more powerfully upon strangers than upon natives, who are habituated to them. The dry and elevated plains, which stretch north from the Anahuac into New Mexico and Arizona, would claim much more of our interest and study were the habits and lives of their greasy original inhabitants more inviting and congenial to the cultivated American. The loose sand and fine lime-dust, together with the larger growth and prevalence of the prickly and inhospitable

[1] *Influence of Climate in North and South America*, J. Disturnel.

[2] *Le Mexique et l'Amérique tropicale, Climate, Hygiène, et Maladies*, par D. Jourdanet.

cactus, as you go south and southwest from Southern Colorado, may reasonably indicate the undesirability of much of that region.

I am informed that the most uninviting places imaginable for the steady abode of man are to be found in some parts of New Mexico and Arizona. In this region the cactus grows to the size of trees; yet here, on the advent of railroads, I predict, will be found the extreme climatic remedy which will suit many consumptives in winter, who are now without much hope anywhere. These excessively dry regions cannot but aid in checking progressive "softening" and drying up profuse catarrhal secretions.

As exceptions to this uninviting region, however, I note the beautifully and favorably located southern slope of the mountains, toward the San Juan River, in southwestern Colorado, where the Pagosa Springs[1] lie, the most wonderful hot springs in America; and the interesting volcanic region, with its genial climate, near Fort Bayard, at an elevation of 6,000 feet.

In the United States, the great plateaus and elevated basins between the Rocky and the Cascade Range, the Sierra Nevada and the Sierra Madre Mountains, present variations in altitude, temperature, and humidity, which would claim our attention could we now spare the time necessary to study so broad a field. Generally having favorable climatic attributes, with unfavorable distances and local peculiarities, we pass over this vast section to mention the western slope of the Sierra Nevada, in California. We refer to the vicinity of the lakes Donner and Tahoe, in summer, and portions of the great Salt Lake basin, and the less known regions south of it towards Arizona, very favorably spoken of by United States surgeons who have had experience there. Our interest is, however, more especially centered in the eastern slope of

[1] See Table of Mineral Springs.

the Rocky Mountains in Wyoming, Colorado, and New Mexico.

The centennial State of Colorado, so newly inhabited and so wide in resources, furnishes, aside from its wonderful climate, a limitless field for investigation. It is only by contrast that its vast area becomes appreciable. Situated between the 102d and 109th degrees of longitude west from Greenwich, and between the 37th and 41st degrees of north latitude, it embraces an area of 105,000 square miles, being larger than the four middle States, nearly as large as New England and New York, or larger than England, Scotland, and Wales, and has an average elevation of more than 6,000 feet above sea-level.

It is not my intention to refer to that portion of the State traversed by the Rocky Mountains proper, or to the unsettled country west of the range, except as special occasion may require. The plains and foot-hills east of the mountains, however, — a field amply sufficient for our study, — furnish a remarkable similarity in climatic attributes.

It is to this section of Colorado that I wish to be understood as referring in this work, unless other localities are specified: namely, that portion lying between the elevation of 4,000 and 8,000 feet, including a belt of country of the same character extending north into Wyoming Territory and south and southwest into New Mexico.

This belt of land varies in altitude chiefly with the location of the rivers, their basins being separated by ridges, called *divides*, which gradually slope into the plains and partake of their prairie characteristics. The divide of Central Colorado, which separates the waters of the South Platte on the north from those of the Arkansas on the south, rises gradually to the height of 2,000 or 3,000 feet above the rivers.

The region we are considering is remarkable, below the

elevation of 6,500 feet, for the absence of trees, except on the banks of streams, where cotton-wood thrives, above this altitude, up to *timber-line*, about 11,000 feet, scrub-oak, mountain-pine, fir, and spruce grow in abundance.

It is in Colorado the Rocky Mountains proper reach their greatest height, presenting a great width, even to one hundred miles. They are interspersed with lofty peaks, — many being over 14,000 feet in height, — and inclose elevated valleys or parks. This natural park system of the Rocky Mountains is one of the most interesting and unique features in the topography of this country. Lying in the order named, from north to south, — North, Middle, South, and San Luis Parks, — at an altitude of 7,000 to 10,000 feet, these mountain valleys differ sufficiently to give each one an individuality peculiar to itself.[1]

We have every indication that these basins were once beds of immense bodies of water, which, breaking through their rocky barriers, cut deep, rugged gorges, or cañons, down which the rivers have flowed for centuries, depositing their débris below the foot-hills. That the plains are overlaid by mountain washings, is very evident to the intelligent observer. I am told that at Towsland, thirty miles east of the foot-hills, in sinking a shaft 113 feet to a coal-bed, the workmen cut through three distinct beds of these former rivers.

Much might be written about the scenery of Colorado. Aside from a lack of space, I must confess myself unable to do the subject justice. It is noteworthy, however, that the Rocky Mountains, with their parks and cañons, offer valuable adjuncts to Colorado's treasures of climate, enticing the invalid tourist to restorative hardships which, without these pleasurable incentives, would

[1] A better knowledge of particular localities will be obtained from the climatic map, and descriptions of health stations, farther on in this work.

never be undertaken. That the mind can forget the bodily ills with which it has long been harassed, is a blessing which comes with the rapture and sublimity excited by Nature's wonders in Colorado. Such are the "Grand Cañon of the Arkansas;" "The Garden of the Gods;" the rugged gorges through the mountains; the lofty mountain peaks towering like "Ossa on Pelion piled" above the lesser heights, giving variegated and extensive views of the surrounding country; the ever-varying grandeur of the foot-hills, mountains, and snow-capped peaks as seen from the plains, now shaded by clouds, tinted with snow, or differently changed by the seasons, and the beautiful sunsets, which in autumn reach a climax of magnificence long to be remembered by the fortunate beholder.

Yet replete as this region is with points of interest, each cañon and resort has its own devotees, ready to testify to its individual claim to distinct merit, beauty, or grandeur.

Some sing the praises of Clear Creek, Cheyenne, Boulder, or Platte Cañons; others prefer the open glades and verdure of the parks above, while still another class delight in the weird mystery of the disintegrated monuments about Colorado Springs and vicinity; yet all admit that the Great Architect has here massed elements of scenic beauty and grandeur, unsurpassed elsewhere.

CHAPTER IV.

CLIMATIC MAP OF THE EASTERN SLOPE OF THE ROCKY MOUNTAINS.

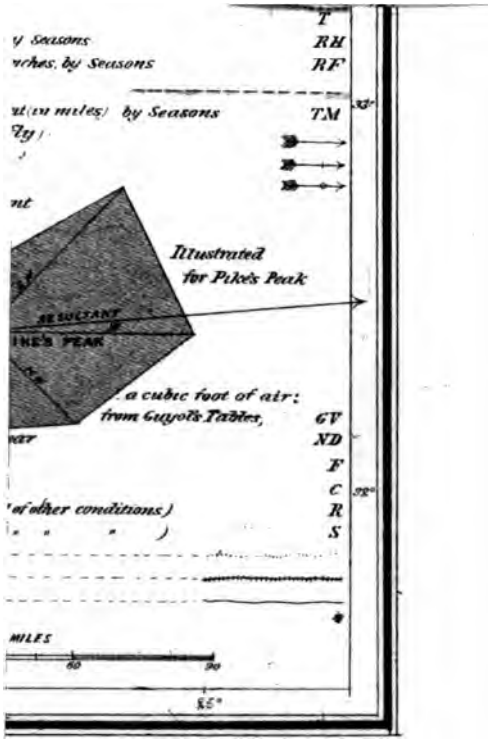
DIRECTIONS. — ISOTHERMAL LINES. — HYPSOMETRICAL PLATS. — RAIN GAUGE LINES. — WINDS, PREVALENCE AND DIRECTIONS. — METEOROLOGICAL DATA.

THIS map, although partially anticipating the conclusions, which the analysis of climatic attributes will furnish of desirable localities, is here introduced, nevertheless, as completing the description of that section of country which occupies our particular attention.

The mean annual temperatures are indicated in the carmine plate by continuous lines which are marked at their extremities for sections differing about four degrees; thus the line of 50° Fahr. runs nearly through Denver, Cañon City, and Santa Fé.

The reader is advised, before attempting to understand the Climatic Map, to read this accompanying explanation carefully, without which it might be liable to the criticism of being too crowded and complex.

As will be apparent by examining these isothermal lines, the differences in temperatures at different localities in this section, — in and east of the Rocky Mountains, and from Central Wyoming to old Mexico, — are due, in a great measure, to elevation rather than to latitude. Consequently the general direction of these isothermal lines is much nearer north and south, than, as usual, east and west. The differently colored contour belts of land are especially useful, as denoting the ap-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proximate elevations of all sections, towns, and places of interest.

These hÿpsometrical belts distinguish different parts of the country, varying in elevation 1,000 feet, below the elevation of 9,000 down to 6,000 feet, and then 500 feet each, below that point:[1] as if levels were run through the rising country at these distances above the sea, and every alternate section were differently colored. The uncolored portions above 9,000 feet, and between the given belts of elevation are represented by figures giving their altitudes, at the top, middle, and base of the map.

The lines in blue give the approximate number of inches of rain or snow (melted), which fall in this region. These estimates are also placed at the ends of the lines. Two sections, one in the basin of the Rio Grande and the other thirty to sixty miles east of the Rocky Mountains in Colorado, are to be noticed as especially dry,— the annual rain fall, so far as yet determined, being eight to ten and twelve inches.

The diagrams indicating the prevalence of winds, as noted thrice daily, for a year, by the Signal Service observers, are lightly colored in the black plate. The prevalence in given directions is represented by the length of the lines radiating from the point of observation, 270 observations of the wind directions being equivalent to an inch, and the winds being represented as on the opposite side of the observation station to that from which they come. The length of the arrows in these diagrams represent the preponderance in the direction indicated. The proportionate velocity of the wind in these directions can only be inferred. This is also the case, although the inference is a trifle stronger, with the small arrows scattered over the map, giving the prevailing direction of the wind. Other valuable wind statistics are

[1] See the different shades under "Explanations" on the map.

given in the little arrows as they fly, — indicating the currents which are likely to bring pleasant weather, — and those which are most likely to bring rain. These statistics of the wind are quite reliable deductions from the Signal Service and United States Army observations, the chief source of the rest of the data given. Especially is this the case with the meteorological tables for important stations on the map which give, for the seasons and for the year separately, the means of temperature (T.); relative humidity — percentage of saturation of the air by aqueous vapor — (R. H.); rain-fall, in inches of rain or melted snow (R. F.); the total monthly movement of the wind in miles (T. M.); the weight of moisture in a cubic foot of air in grains (G. V.), and the number of clear and fair (F.) and cloudy (C.) days in a year, with the separate reckoning of the number of days (R.) on which rain fell, also those (S.) on which snow fell.

The railroads, mineral springs, and some of the wagon roads of this section, are also appropriately indicated. (See explanations on the map.) Barometrical observations are not included, as no appreciable benefit could be derived therefrom, independent of the information the map already contains. Thus an endeavor has been made to condense into a small space the most trustworthy climatic data attainable, the records varying as to continuance from one to five years or more.

CHAPTER V.

MINERAL SPRINGS AND OTHER HEALTH-STATIONS.

MIDDLE PARK. — IDAHO. — SPRINGDALE. — BOULDER. — ESTES PARK. — MORRISON. — NATURAL MONUMENTS. — SOUTH PARK. — MANITOU. — CAÑON CITY. — PUNCHA PASS. — LIBERTY HOT SPRINGS. — ANTELOPE PARK — PAGOSA SPRINGS. — OTHER RESORTS IN SOUTHWESTERN COLORADO. — OJO CALIENTE. — LAS VEGAS — TRINIDAD. — PUEBLO. — COLORADO SPRINGS. — DENVER.

BY many physicians of the Old World, who have made a study of the cure of phthisis, mineral and thermal springs, as medicinal agents, are considered next in value to climate, undoubtedly on account of their beneficial effect upon digestive and nutritive disorders which so often underlie, or complicate consumption.[1] In this respect the eastern slope of the Rocky Mountains offers every possible inducement to the invalid.

There are few if any regions in America richer in mineral springs than Colorado, yet it is impossible to do full justice to the curative properties of the whole number, as but a small portion have, as yet, been subjected to quantitative analysis, and few have been tested as to the effect of their medicinal qualities upon disease.

Table VI. gives the component parts of those springs which have been analyzed, together with the analyses of a few other waters of curative note. It will be seen that the springs of the Rocky Mountain region do not suffer in comparison with the famous Hot Springs of Arkansas, the calciferous waters of Waukesha, Wisconsin, noted for their cure of kidney complaints, or the renowned chalybeate sources of St. Moritz, Switzerland.

[1] "In our opinion," says Niemeyer, "the use of the alkaline muriatic springs has, in many patients, a really curative influence."

TABLE VI.

In 100,000 Parts of Spring Water are contained	Middle Park, Hot Sulphur. 117° F. (Prof. E. J. Mallett, Jr., Colorado School of Mines.)	Idaho Hot Springs. 109° F. (Dr. I. G. Poble, New York.)	Seltzer, Springdale. (Chas. T. Jackson, State Assayer of Mass.)	River Spring, Estes Park. 89° F. (Prof. C. F. Chandler, Columbia College, N. Y.)	Ranch Spring, Estes Park. 89° F. (Prof. C. F. Chandler.)	Porter Spring, North Denver. 69° F. (Prof. E. J. Mallett, Jr.)	South Park Springs. (Prof. Geo. E. Patrick, Kansas University, Kansas.)	Iron Duke, Cañon City. (Prof. Leon, of Wheeler Expedition.)
Carbonate of Soda	38.44	52.81	9.37 [1]	– –	– –	9.97	180.55	131.69
Carbonate of Lithia	Trace.	– –	– –	– –	– –	– –	– –	Trace.
Carbonate of Lime	11.02	16.32	74.29	2.84 [1]	6.89 [1]	17.63	19.89	56.58
Carbonate of Magnesia	– –	4.94	1.14 [1]	2.01 [1]	1.83 [1]	1.71	11.09	25.03
Carbonate of Iron	2.34	7.07	6.86 [1]	6.66 [1]	8.12 [1]	Oxide. 2.57	– –	Trace.
Sulphate of Potassa	2.90	– –	– –	.99	1.09	.52	– –	– –
Sulphate of Soda	43.06	50.34	184.46	– –	– –	47.23	9.69	20.92
Sulphate of Magnesia	– –	82.09	– –	– –	– –	– –	– –	– –
Chloride of Sodium	22.48	7.13	8.51	1.31	1.32	9.14	165.03	142.32
Chloride of Magnesium	– –	– –	– –	– –	– –	1.96	– –	– –
Chloride of Potassa	– –	– –	– –	– –	– –	– –	82.58	– –
Sulphide of Sodium	– –	– –	– –	– –	– –	8.27	– –	– –
Silicate of Soda	– –	6.99	6.86	– –	– –	1.54	– –	– –
Ammonia	Trace.	– –	– –	– –	– –	Trace.	– –	– –
Alumina	– –	– –	– –	Trace.	Trace.	– –	.65	– –
Silica	– –	– –	– –	.78	.99	– –	.92	– –
Iodide and Bromide of Sodium	– –	– –	2.23	– –	– –	– –	– –	– –
Organic Matter	– –	– –	– –	1.79	2.06	– –	Sulphur.[2]	– –
Total	120.24	177.69	293.72	16.38	17.30	95.54	870.40	376.54
Gases	Car. ac.	Car. ac.	– – [3]	– – [3]	– – [3]	Sul. hy. Car. ac.	Car. ac.	– – [3]

[1] Bi-carbonates. [2] Amount undetermined [3] Gases not given.

TABLE VI., — *continued.*

In 100,000 Parts of Spring Water are contained	Little Ute, Cañon City. (Prof. Leon.)	Hot Spring, Cañon City. 102° F. (Prof. Leon.)	Carlisle, near Pueblo. 68° F. (Wheeler Expedition.)	Bethesda, Waukesha, Wis. 68° F. (Prof. C. F. Chandler.)	Red Sulphur, West Virginia. 54° F. (Prof. A. A. Hayes.)	Seltzer, Saratoga, N. Y. 50° F. (Prof. C. F. Chandler.)	St. Moritz, Old Source. Switzerland. 42° F. (Drs. Planta and Kekulé.)	Navajoe, Manitou. 52° F. (Wheeler Expedition.)
Carbonate of Soda	131.00	125.51	15.42	1.50	– –	35.01	19.04	134.69
Carbonate of Lithia	Trace.	Trace.	– –	– –	– –	.97	– –	.25
Carbonate of Lime	38.58	56.07	38.40	20.27	9.00	107.05	72.64	129.40
Carbonate of Magnesia	24.00	21.95	19.52	12.59	8.26	40.99	12.54	81.60
Carbonate of Iron	Trace.	– –	.51	.05	– –	2.12	2.37	– –
Sulphate of Potassa	– –	– –	1.20	.78	– –	.94	1.64	16.21
Sulphate of Soda	20.76	135.97	34.28	.93	7.11	– –	27.23	18.42
Sulphate of Lime	– –	– –	– –	– –	.95	– –	– –	– –
Chloride of Sodium	202.33	31.07	19.30	1.99	– –	230.25	8.89	89.78
Chloride of Magnesium	– –	– –	– –	– –	– –	– –	Phos. .04	– –
Chloride of Potassa	– –	– –	– –	– –	– –	2.29	– –	– –
Alumina	– –	– –	– –	.21	– –	.64	.03	– –
Silica	– –	– –	Trace.	1.26	1.40	4.39	8.81	1.47
Iodide and Bromide of Sodium	– –	– –	– –	– –	– –	1.14	Trace.	– –
Organic Matter	– –	– –	Trace.	– –	14.39	– –	– –	– –
Total	416.67	370.57	128.63	42.98	41.11	425.80	143.64	361.60
Gases	– –[1]	– –[1]	Car. ac.	– –[1]	Sul. hy. Car. ac.	Car. ac.	– –[1]	Car. ac.

[1] Gases not given.

TABLE VI., — *continued.*

In 100,000 Parts of Spring Water are contained	Ojo Caliente, New Mexico. 109° F. (Prof. O. C. Marsh, New Haven, Conn.)	Parnassus, near Pueblo. 72° F. (Wheeler Expedition.)	Hot Springs, Arkansas. 85° — 150° F. (Geo. E. Walton, on Mineral Springs.)	Gastein, Austria. 87° – 109° F. (Wolf.)	Ems, Germany. 112° F. (Fresenius.)	Spa, Belgium. 80° F. (Monheim.)	Las Vegas Hot Springs, (No. 3), New Mexico. 126° F. (Hayden's U. S. Geological Survey.)	Chalk Creek Hot Springs, Chalk Creek, Col. 130° F. (Prof. G. E. Patrick, Lawrence, Kansas.)
Carbonate of Soda	196.95	118.45	– –	.57	150.54	10.00	Na. 5.00	– –
Carbonate of Lithia	.21	1.78	– –	Mang. .28	Mang. .15	– –	– –	– –
Carbonate of Lime	4.17	54.54	6.80	5.14	17.99	8.29	} 11.41	8.85
Carbonate of Magnesia	2.18	22.43	.22	.28	12.16	8.44	}	1.08
Carbonate of Iron	10.12	2.23	Sesquiox. .18	.71	.29	9.07	– –	– –
Carbonate of Potassa	– –	– –	– –	– –	– –	– –	– –	.23
Chloride of Potassium	– –	– –	– –	– –	– –	– –	– –	1.09
Sulphate of Potassa	5.17	18.44	.39	.14	5.62	– –	– –	– –
Sulphate of Soda	13.60	8.98	.64	21.57	.09	– –	16.27	10.58
Sulphate of Lime	– –	– –	.19	– –	– –	– –	– –	– –
Chloride of Sodium	38.03	53.23	.01	5.14	111.01	2.24	27.34	– –
Silicate of Soda, No. 2, Li. 03	– –	– –	Lime. .79	– –	– –	– –	– –	4.45
Alumina	– –	– –	.77	.57	.14	Car. .34	– –	– –
Iodide and Bromide of Sodium	– –	– –	Trace.	– –	– –	– –	– –	– –
Silica	2.10	6.00	8.19	8.43	5.21	8.10	– –	8.49
Potassium	– –	– –	– –	– –	– –	– –	Trace.	– –
Lithia	– –	– –	– –	– –	– –	– –	Strong trace.	Trace.
Silicic Acid	– –	– –	– –	– –	– –	– –	2.51	– –
Iodine	– –	– –	– –	– –	– –	– –	Trace.	– –
Bromium	– –	– –	– –	– –	– –	– –	Trace.	– –
Organic Matter	– –	– –	1.21	Trace.	– –	– –	– –	Trace.
Total	272.53	333.92	14.39	37.88	308.10	37.08	62.53	24.27
Gases	Car. ac.	Car. ac. Sul. hy.	– –[1]	– –[1]	– –[1]	Car. ac.	– –[1]	Car. ac., oxygen, nitrogen, etc.

[1] Gases not given.

TABLE VI., — *continued.*

In 100,000 Parts of Spring Water are contained	Manitou, Manitou. 59° F. (Wheeler Expedition.)	Ute Soda, Manitou. (Wheeler Expedition.)	Shoshone, Manitou. 48° F. (Wheeler Expedition.)	Iron Ute, Manitou. 44° F. (Wheeler Expedition.)	Little Chief, Manitou. 47° F. (Wheeler Expedition.)	Liberty Spring, No. 1, Wagon Wheel Gap. 150° F. (Wheeler Expedition.)	Liberty Spring, No. 3, Wagon Wheel Gap. 140° F. (Wheeler Expedition.)	Pagosa, San Juan 140° F. (Wheeler Expedition.)
Carbonate of Soda	52.26	23.82	88.80	59.84	15.16	69.42	144.50	4.70
Carbonate of Lithia	.21	Trace.	Trace.	Trace.	Trace.	Trace.	Trace.	.71
Carbonate of Lime	111.00	40.00	108.50	59.04	16.20	13.08	22.42	59.00
Carbonate of Magnesia	20.57	6.10	- -	14.56	13.01	10.91		4.85
Carbonate of Iron	Trace.	1.40	- -	5.78	1.30	- -	- -	- -
Sulphate of Potassa	13.35	Trace.	5.12	7.01	6.24	Trace.	Trace.	7.13
Sulphate of Soda	19.76	12.24	37.08	30.86	51.88	23.73	13.76	221.66
Chloride of Sodium	40.95	13.93	42.12	31.59	47.97	29.35	33.34	29.25
Silica	2.01	Trace.	Trace.	2.69	2.22	5.73	4.75	5.70
Organic Matter	- -	- -	- -	- -	- -	Trace.	Trace.	Trace.
Total	260.00	97.49	281.62	210.87	213.48	152.12	218.77	333.00
Gases	Car. ac.	Car. ac.	Car. ac.	Car. ac.	Car. ac.	Sul. hy.	- -[1]	Car. ac. Sul. hy.

[1] Gases not given.

MIDDLE PARK, HOT SULPHUR SPRINGS.

These springs, six in number, situated upon the banks of Grand River, which flows through Middle Park, are accessible through the summer months by tri-weekly stage from Georgetown over Berthoud Pass, 11,350 feet above the sea.

The springs unite in a common stream, and flow over a ledge of rocks into a natural basin, over which the bath-house, with ante-rooms adjoining, is built. Into this steaming caldron the bather ventures, and if he have physical ails for which sulphurous fumes are a panacea, he cannot but be benefited. The hotel accommodations are comfortable, although many avail themselves of the medicinal virtues of these waters by pitching their tents in the vicinity. It would be difficult to select a more delightful spot for camping than Middle Park. It differs from the park proper, — as typified by South and San Luis Parks, — presenting a basin bounded by peaks of the snowy range, and broken up into a succession of valleys,[1] through which the Grand River and its tributaries gather their head-waters and flow toward the Pacific. High up among the mountains, southwest from the Hot Sulphur Springs, are some effervescing soda springs, as yet unimproved.

IDAHO SPRINGS.

The hot soda springs and mineral baths at Idaho, thirty-five miles west, and 2,500 feet higher than Denver, may be reached by the Colorado Central Railroad, through Clear Creek Cañon, a gorge equal, in the opinion of many, to any in Colorado, for beauty and sub-

[1] Grand Lake, at the head of the park and of the river of the same name, lies at an altitude of about 9,000 feet, in a niche of the Snowy Range, almost encircled by rocky cliffs. Numerous streams throughout the park furnish sport for the fisherman, while the hills around abound in game.

limity. By reason of its proximity to the heated plains, and its easy accessibility by rail, this little town has already become a popular resort with those who wish to avail themselves of its tonic atmosphere and medicinal waters. We find here public and private baths, either hot or cold, fine hotel accommodations, and varied amusements. It is said a large and commodious hotel is to be erected here by the managers of the Colorado Central, which will render this place a delightful and desirable residence for invalids, at any time of the year.[1]

SELTZER SPRING.

This spring is found at Springdale, a little place nine miles from Boulder,[2] on a stream primitively called "Jim Creek," and may be reached by the Colorado Central to Boulder, and thence by stage or private conveyance to Springdale.

The waters of the Seltzer are effervescent, agreeable, and, as will be seen by referring to the tabulated analysis, strongly impregnated with iron. They would naturally afford relief to those afflicted with dyspepsia, or chlorotic disorders.

The bath-house, with hot and cold baths, adjoins the hotel, which offers inducements to the traveler in the modern convenience of saddle-horses and "mountain rigs."

[1] Chicago Lakes, two beautiful little sheets of water, twelve miles distant, — one of which, at an altitude of 11,500 feet, is the highest body of water in North America, — are reached from this place.

[2] Boulder itself is a thriving place of considerable business activity and public spirit, numbering three thousand or more inhabitants. It is contiguous to a large mining district, and therefore the supply-depot for several mining camps.

The Colorado State University is located here, and the invalid and tourist will find much of interest in Boulder and its surroundings. Boulder Cañon, in particular, with its rugged and romantic scenery, is especially attractive.

ESTES PARK.

This little mountain park, containing about ten square miles, lies northeast of Long's Peak, 7,500 feet above sea level. In general contour it is not unlike the other valleys which make up the park system of Colorado, abounding in gentle slopes, dark pines, and beautiful winding trails, leading from the open glades of the valley up dark cañons. Its clear brooks, fed by snow-banks, high up on the mountain sides, and filled with speckled trout, unite in one large stream, the Big Thompson, which breaks its way through the hills to the plains below. The view, from any of the neighboring mountains, of this charming little valley is one of tranquil beauty, in marked contrast with the sublimity of its surroundings.

The traveler leaves the Colorado Central at Longmont, and by stage follows the winding course of the St. Vrain through one of the finest agricultural districts of the New West; or, from Loveland, he surmounts the crests of successive mountains; in either case entering the Park at the base of Mount Olympus, which guards the entrance to the valley.

The larger portion of Estes Park is in the hands of an English company, who have a hotel, which overlooks one of the most delightful parts of the valley. Good board can be reasonably obtained also at the ranches in the vicinity, either with or without tent accommodations.

The superior attraction of this place, however, consists in the facility with which the invalid may obtain gentle saddle-horses, and take desirable horseback exercise in visiting the numerous places of interest within available distances.

It is to be regretted that the springs, called "River" and "Ranche," which under more favorable circum-

stances might be made powerful coadjutants to the hygiene of this place, have not been improved and rendered attractive. The table indicates that they are strong ferruginous waters, though rather weak in total solids. If surface drainage were entirely eliminated, they would undoubtedly prove still stronger.

The form of iron is said, by Professor Chandler, of the School of Mines, Columbia College, to be the *bi-carbonate*, which, being easily assimilated, would seem to render these waters particularly desirable in cases characterized by anæmia and general debility.

MORRISON SPRINGS.

These cold sulphureous waters are at Morrison, within the foot-hills, about one hour's ride from Denver, on the Morrison branch of the Denver and South Park Railroad. No quantitative analysis has yet been made, although they have been somewhat improved, and are said to be beneficial in dyspepsia.[1]

There is a fine hotel here, the Evergreen House, which is to be kept open winter and summer. This locality is rendered the more desirable on account of its proximity to Denver. It is both a stepping-stone to higher elevations, and furnishes an excellent opportunity for the *climbing treatment*.[2]

[1] Prof. G. E. Patrick kindly made for me a qualitative analysis of these waters, and from this the spring would seem to be somewhat like the Porter Spring (see Table). The total solids are 32.8 in 100,000 parts, with a trace of organic matter.

[2] The hill-sides above Morrison are dotted with monoliths and huge grotesque masses of dark red sandstone, standing isolated or in clusters. These singular rock formations extend along the eastern base of the mountains, culminating in picturesque groupings near Colorado Springs. In the southwestern part of the state, near the Rio Grande, these peculiar distortions are seen in the form of massive arches, pyramids, and huge, stone-capped monsters, — fantastic and curious products of erosion.

SOUTH PARK.

Passing by chalybeate and alkaline or sulphureous springs, at present undeveloped but of undoubted value, — especially a large chalybeate flow over a huge ledge of ferruginous ore, high up in the hills, twelve miles from Grant Post Office, — we come to South Park. This is a vast amphitheatre lying east of the great continental divide, at an elevation of from 8,000 to 10,000 feet. In some respects South Park is considered the most attractive of the mountain parks, presenting as it does many clusters of peaks which surround this undulating plateau.[1]

Bayard Taylor, writing several years since of his impressions of this park, says: "Whatever effect the climate of the Rocky Mountain region may have upon permanent settlers, there is no doubt that for travelers it is one of the most favorable in the world. It takes fat from the corpulent and gives it to the lean; it strengthens delicate lungs and paints pallid faces with color and invigorates every function of the system."

The South Park Springs,[2] saline alkaline, and Hartzell's Hot Sulphur Spring, lie on the bank of the South Platte River, in the southern portion of the park.

As the latter springs have not been subjected to analytical examination, it is impossible to speak definitely of their efficacy.

From Fairplay the traveler can cross the Park Range into the upper Arkansas Valley, where lies the new rich silver field and carbonate camp of Leadville, now a thriv-

[1] From the summit of Mount Lincoln, which stands on the western rim of this great basin, fifty peaks over 13,000 feet high, and two hundred which are 12,000 feet high and upward, can be counted.

[2] See Table. The chemist who analyzed these waters, Professor G. E. Patrick, of Kansas University, allowed me to make use of his analysis, with the statement that the quantity of water furnished him for test was so small, he could make no calculation of the sulphur contained.

ing and populous city over 10,000 feet above sea-level. Thence about eight miles south he may reach the beautiful Twin Lakes nestling at the base of the Saguache Mountains. Many visitors frequent this charming little resort, 9,400 feet above the sea, attracted hither by its grand scenic surroundings and the opportunities it affords for fishing and hunting. From the summits of the mountains which overlook the lakes, may be seen, far away to the south, Ouray and Uncompahgre Peaks; in the east, across the meadow-like expanse of the South Park, Pike's Peak cuts off the plains, and farther north Mount Lincoln sentinels the horizon. Northwest, beyond our ken, mountain-locked and almost inaccessible, the Mount of the Holy Cross rears its symbol of faith amidst a wilderness of peaks.

MANITOU SPRINGS.

Seventy-five miles south of Denver and six miles west of Colorado Springs, is the little village of Manitou Springs. It lies at an elevation of 6,370 feet, at the foot of Pike's Peak, in a little valley sheltered on three sides by the hills. Fountain Creek, — La Fontaine Qui Bouille — which emerges from the mountain by the Ute Pass, runs through the valley.

The springs, six in number,[1] which render this little place famous, bubble up near each other, upon the banks of Fountain Creek and its immediate tributary, Roxton's Creek. They lie in the following order: the Shoshone and Navajoe, muriated alkaline; the Manitou and the Ute Soda, acidulous alkaline; the Iron Ute, chalybeate alkaline, and the Little Chief, aperient.

Long before the medicinal virtues of the springs of this region were known to the white settlers, the Indians of the Rocky Mountain tribes were accustomed to bring hither their sick and afflicted to drink of and bathe

[1] See Table.

in these waters, appropriately applying the name Manitou, or "Great Spirit," to an agency of relief they deemed supernatural. These springs, with their picturesque surroundings and tonic atmosphere, yearly attract many invalids to Manitou, which is rapidly gaining favor, both as a summer and winter resort. In his brochure upon the mineral waters of this locality, Dr. S. E. Solly remarks: "The Manitou and Navajoe have been highly praised for their relief of old kidney and liver troubles, and the Iron Ute for chronic alcoholism and uterine derangements. Many of the phthisical patients, who come to this dry, bracing air in increasing numbers, are also said to have drank of the waters with evident advantage."

The hotels — The Mansions (Beebe), Manitou House, and Cliff House, — offer the usual resources of the fashionable watering place as to accommodations, amusements, and a supply of horses and carriages. The great charm of this resort, aside from the attractions mentioned, lies in its contiguity to various places of world-renowned interest. Within a radius of a few miles one may visit the far-famed Garden of the Gods, Glen Eyrie, Monument Park, Cheyenne Cañon, Ute Pass, and many other attractive places, or ascend to the summit of Pike's Peak.

By the Ute Pass the traveler may gain access to South Park and eventually reach Fair Play and Leadville; or he may turn aside, after a twenty miles' ride, and find rest and quiet among the pines of Manitou Park, 1,200 feet higher than the springs. Because of its coolness and favorable location, this is becoming quite a summer resort for invalids.

CAÑON CITY.

Although the title is an evident misnomer, — a common fault in the nomenclature of Rocky Mountain towns, — yet, at its present rate of growth, Cañon City may sometime justify its name and take rank with western

cities, having already a reputation for unusual business activity.

The altitude is about that of Denver, and as the town is protected by mountain ranges from harsh northern winds, the winters are mild and inviting, although the fine dust which is swept from the dry, *adobe* soil, by the currents of wind drawn through the adjacent cañon of the Arkansas, is considered by many a disagreeable feature.[1]

The mineral springs at Cañon City are both warm and cold, and have bathing establishments connected with them for the use of visitors. Professor Leon, the chemist of the Wheeler Expedition, whose analysis of these waters we give, tells us that "in mineral constituents and temperature they are very similar to Vichy." There are other springs, — chalybeate, sulphur, and soda, — as yet unimproved.

From Cañon City the tourist should visit the Grand Cañon of the Arkansas, concerning which so much has already been said and written. Here the Arkansas River has cut its way through mountains of solid rock for several miles, the walls of the cañon rising precipitously nearly 2,000 feet. A railroad is now built through this cañon Leadvillewards, which will give all who wish an opportunity of seeing this immense mass of perpendicular rock from the base. Heretofore the bed of the cañon has been inaccessible except in mid-winter upon the ice.

[1] A branch of the Denver and Rio Grande Railroad leaves the main line at Pueblo, and follows the Arkansas River to Cañon City. We should not forget to mention, in passing, the fine farming region south of Cañon City, at an altitude of 7,500 feet, known as Wet Mountain Valley, running thirty-five miles southeast and northwest, with an average width of six miles. This valley is known as "The Briton's Paradise," on account of the number of Englishmen who have made their homes there, and is particularly noted for its agricultural and dairy products. In this valley is also the new mining centre and town of Silver Cliff, already become famous through the richness of its recent mineral discoveries.

PUNCHA SPRINGS.

About sixty miles west of Cañon City, and accessible by the Denver and Rio Grande Railway in Puncha Pass, at an elevation of about 8,000 feet, lie a collection of springs, both hot and cold, which are destined sometime to form one of the prominent attractions of Southwestern Colorado.

The hot springs, — 120° Fahr., — the waters from which flow over a ledge into a natural basin, are thirteen in number. No analysis has been made of these waters, as the knowledge of their therapeutic efficacy is of recent date; yet sulphur and soda are said to form important constituents. They have already attained so much local reputation, that the proprietor advertises comfortable accommodations for fifteen or twenty persons.

If we follow the Arkansas valley north from Puncha Pass, we reach within twenty or thirty miles the springs of *Chalk Creek*, which are five miles from the Arkansas River. These are about twelve in number, at various temperatures, the hottest being about 150°.Fahr. Connected with one of them is a clay or mud bath, similar to that at Hot Springs, Arkansas, temperature 130° Fahr. Some of these springs are decidedly ferruginous. Their altitude is about 8,000 feet.[1]

Still farther north are the *Cotton-wood Creek* thermal springs, of which little is as yet known.

LIBERTY HOT SPRINGS, WAGON WHEEL GAP.

Thirty-one miles west of Del Norte, on the Rio Grande River, accessible by stage from the railway at Alamosa, are the thermal waters of Wagon Wheel Gap. Here the Rio Grande cuts its way through lofty, rugged mountains, between Sahwatch Range on the north and Summit Range on the south.

[1] See analysis in Table.

The springs are three in number,[1] with passable bathing and boarding accommodations. As will be seen, the first spring tabulated is purgative, being impregnated with sulphate of soda, — Glauber's salt. These waters boil up in an oval, natural basin, seven by eleven feet along its two axes, at a temperature of 150° Fahr., and are utilized for bathing purposes. The other spring is hot soda, pure, bright, sparkling and pleasant to the taste; yet its extreme alkalinity naturally prevents its use as a continual beverage.

These waters have already gained a local reputation for their specific effect upon aggravated cases of rheumatism and skin diseases; No. 3 is especially recommended, I am told, for diseases of the kidneys, and No. 2 is used for "liver complaints and general debility." With the extension of the Rio Grande Railway to Del Norte, the general public will have a better opportunity of testing their curative properties. Following the narrow valley of the Rio Grande twenty miles west, we reach Antelope Park, where some hot and cold springs containing sulphur and soda have been discovered. These waters are called *Antelope Springs.*

PAGOSA SPRINGS.

The advance of agricultural and mining interests in southwestern Colorado is gradually revealing the endless resources of the San Juan country, part of which, including the Pagosa Springs, has but recently been ceded to the United States government by the Indians for whom it was formerly reserved.

These springs lie upon the northern bank of the San Juan River, at an altitude of 7,000 feet, and in a situation combining numerous advantages and attractions. To the north are the peaks of the San Juan range; east and west reach grassy plains dotted with immense

[1] See analyses of two of these springs in Table.

pines; and far to the south the undulating prairie stretches into New Mexico. With such an environment, the Pagosa Springs must ere long gain the celebrity to which their medicinal qualities undoubtedly entitle them.

The Indians have long been aware of the healing powers of these "great medicine waters," and have, until recently, jealously guarded their possession. It is not surprising that these children of the wilderness, who find relief from distress mainly in the medications of nature, should deplore the loss of these powerful thermal waters.

Within a basin seventy feet long and fifty wide, formed from its own alkaline deposits, which are twenty or thirty feet thick, the water bubbles up at a temperature of 140° Fahr. There are four other springs in the immediate locality, their similarity to the main source, as shown by analysis, suggesting a common origin. Upon a cold morning the steam which rises from these different springs can be seen at a distance of several miles.

These purgative, alkaline waters, with the large excess of sulphate of soda, so much increased in medicinal virtue by the high degree of temperature,[1] would seem to designate Pagosa as the Bethesda for sufferers from calculous disorders, gravel with uric acid diathesis, rheumatism and skin diseases, when alterative and depleting treatment is indicated.

Pagosa Springs are now reached by trail from Del Norte, or wagon road from Alamosa and Conejos, and will soon be rendered easy of access as the Rio Grande Railroad is advancing towards the San Juan Mines and Arizona via this place.

In this connection several mineral springs in southwestern Colorado are mentioned, which have been re-

[1] According to the opinion of Sir Henry Thompson.

cently discovered, but which will yet be reputed of great medicinal value.[1]

About thirty miles south of Silverton is an open, fertile park, called Animas Valley. Here are the *Iron Springs of Elbert*, similar in taste to the Iron Ute at Manitou. *Pinkerton's* alkaline spring, the waters from which flow into a natural bath-tub, cut from the solid alkaline deposit; also, a cold soda spring, emitting carbonic acid, pleasant and refreshing to the taste.

About twelve miles west of Silverton, near Silverton Pass, is an *iron lake*, seventy-five feet in diameter and from ten to twenty feet in depth. Its waters are cold, clear as crystal, with a strong chalybeate taste. People in the vicinity speak of their effect as tonic and appetizing.

Farther north, in the vicinity of Ouray, which is situated at the junction of the Uncompahgre and Cañon Creek, are several mineral and thermal springs, at an altitude of 7,300 feet. These consist of *six* hot alkaline springs, varying in temperature from 120° to 140° Fahr., having a bath-house with plunge and shower baths attached; *two* cold springs, slightly impregnated with sulphur; and *one* sulphur spring, similar to those in Middle Park, giving off sulphureted hydrogen and carbonic acid at a temperature of 134° Fahrenheit.

Not far distant, near the mouth of Cañon Creek, is a warm chalybeate spring, temperature, 136° Fahr.; and a short distance up the stream a spring containing *bitter salts* in large quantities; temperature, 130° Fahr.; also, a *hot soda* spring, temperature 158° Fahr., which rushes in an immense stream from under a rocky ledge.

Nine miles north, in Uncompahgre Park, are the *Ouray Mineral Springs*, held in great veneration by the Indians on account of the cures effected by the waters,

[1] For data in regard to these springs, I am indebted to the report to State Board of Health for 1877, by Dr. T. G. Horn.

— temperature 120° to 140° Fahr., — containing sulphate of soda as a chief constituent. The alkaline deposit from these springs covers several acres.

A short distance above the mouth of Dallas Fork are the springs which give the name of *Uncompahgre* — red water spring — to the river and park. They are warm, and surrounded by a red deposit, consisting mainly of iron oxide.[1]

OJO CALIENTE, NEW MEXICO.

Ojo Caliente is an old Mexican town west of the Rio Grande, and has been but little *Americanized*, although many invalids yearly visit the place to test the curative effects of its climate and waters. The latter are said to have a very beneficial influence in constitutional and skin diseases, but are extremely relaxing.[2] I have been informed that, in the case of an obstinate dislocation of the hip-joint, the patient was immersed in these waters at their normal heat, and the muscles became so relaxed the bone easily slipped into place.

This fact might also be construed as a warning against the indiscriminate use of thermal or mineral waters. Many individuals are injured rather than benefited by using powerful mineral waters without professional advice; consumptives, particularly, are known to have been injured by bathing in the debilitating waters of these springs.

The Denver and Rio Grande Railway from the north, and the Atchison, Topeka, and Santa Fé from the east, are already in process of extension towards Ojo Caliente, so that this resort, and other favored localities in New Mexico, will soon be opened to the invalid world.

[1] *Hayden's Survey*, 1875.

[2] See Table.

SANTA FÉ.

This is an old Mexican town, lying in a valley 7,000 feet above sea level, surrounded by low hills, covered with piñon trees. The town is composed of low, adobe houses, and is laid out, — like other Mexican cities, — around a plaza, where the business interests centre. The climate of Santa Fé is delightfully cool in summer, and mild in winter, and with the ingress of the railroad, which has reached this place during the past year, this will probably become a favorite resort, especially in winters.

LAS VEGAS SPRINGS, NEW MEXICO.

About five miles from Las Vegas, on the Rio Gallinas, before it leaves the mountains, are ten flowing hot springs at a temperature of 130° F., somewhat impregnated with sulphur, and with traces of potassium, iodine, and bromine, which indicate its use in constitutional diseases.[1]

Las Vegas is situated on the eastern slope of the mountains, in the midst of delightful scenery, with ample opportunities for out-door recreations and sports. This point is reached by the Atchison, Topeka, and Santa Fé Railway.

PUEBLO.

This place, which stands upon the site of a former *pueblo* or Mexican village, is divided into Pueblo proper and South Pueblo by the Arkansas River. It is an enterprising town, with a growing population, and derives its chief importance from the railroad interests which centre here.[2]

[1] See analysis in Table.

[2] Being at the intersection of the Denver and Rio Grande and the Atchison, Topeka, and Santa Fé roads, and the last place of considerable size on the latter, it serves as an outfitting depot for the vast agricultural and mining districts south and west.

A pleasant drive of twelve miles, southwest from Pueblo, takes us to Parnassus Springs, among the foot-hills of the Greenhorn Mountains. These waters — muriated alkaline — have been tested with marked benefit, especially in cases characterized as gastric complaints.

Carlisle Springs are situated twenty miles above Pueblo on the Arkansas River. These purgative alkaline waters are as yet unimproved.

COLORADO SPRINGS.

This thriving little city, which takes its name of Springs from Manitou, six miles distant, is situated on the Denver and Rio Grande Railroad, seventy-five miles south of Denver at the base of Pike's Peak. Its wide avenues, lined with tasteful residences, fine public buildings and rows of shade trees, all evidence the enterprising spirit of its citizens.

Colorado Springs derives its chief importance from its contiguity to Manitou; it is the home also of a cultivated class of people, who have been attracted to the State by health considerations. Colorado College was established here in 1874, and has since grown with the educational needs of the country. The altitude of this place is about 6,000 feet.

DENVER.

After one has traveled for hundreds of miles over the arid plains which lie between the wheat-fields of Kansas and the base of the Rocky Mountains, he can never forget his first impressions of Denver, "The Queen City of the Plains." Buried in cotton-wood trees and shrubbery, with a background of hills, the city appears a refreshing change from the monotony of buffalo-grass, ant-hills and cactus which extend north, east, and south as far as the eye can reach.

To the traveler, who has been out of sight of land upon this inland ocean of prairie for twenty-four hours,

the first glimpse of the city comes like a revelation, — an inkling of better things, — an impression which a more familiar acquaintance with the resources of the place proves by no means delusive.

As seen across the plains from the city, the mountains, which residents of Denver and Colorado generally consider their own peculiar heritage, present a magnificent appearance. Apparently only two or three miles distant, — owing to the wonderful clearness of the atmosphere, — they are in reality twelve or fifteen miles away, and seem to sweep around the city in the segment of a circle, in three tolerably distinct tiers from Long's Peak, fifty miles north, to Pike's Peak, eighty miles south. The foot-hills, the first tier, rise two or three thousand feet above the plains, seamed with cañons and gorges, or dotted with sunny pastures; the second tier rises still higher and more indistinct, while above all the glistening peaks of the snowy range rise 13,000 or 14,000 feet into the intense blue sky.

Denver, lying at an altitude of 5,200 feet, is regularly laid out in wide, well-shaded streets, which are naturally paved by the sandy, porous soil and, as a whole, are in a better condition for driving, during the entire year, than those of any other city, east or west, with artificial pavements.

As year by year Colorado becomes better known as the El Dorado of the West, Denver rapidly adapts itself to the increasing demand of the transient public. It is provided with broad thoroughfares and diverging street railways; with gas-mains, Holly water supply, and miles of irrigating ditches, extending throughout the city. By improving the opportunities the mountain railroads offer, one may be quickly transferred to entirely different surroundings and new atmospheric conditions.

In business thrift and activity Denver gives the impression of being a much larger city than actual compu-

tation would show it to be. Beginning an existence on the apparently barren plains of the Great American desert in 1859, and maintaining an existence despite the devastations of fire, flood, Indians, and grasshoppers, its inhabitants numbered in 1865 about 7,000; in 1870, 12,000; in 1875, 20,000, and at the present time over 35,000. Its claims as the future metropolis of this New West are based upon the enterprise and thrift of its business men; its wholesale, retail, banking, and manufacturing establishments; its position as capital of this centennial State and county seat of Arapahoe County, the home of numerous mining and corporate institutions, the location of the Boston and Colorado Smelting Works, — the largest smelting works in the world solely for extracting gold and silver, the main distributing point for Colorado, New Mexico, and Arizona, the converging point of six prosperous railroads, and the objective destination of their powerful allies or contestants; and, in fine, because it is the destination annually of thousands of health-seekers, tourists, miners, and others, — the city probably averaging 5,000 transient population throughout much of the year.

The hotel accommodations, as in most towns of any size in Colorado, are numerous and varied to suit the average demand of a new country like this. One may grade his expenses to his means, though it is to be regretted that this process too often involves being stowed away in small rooms, which have too little sunshine and are near uncleaned alleys or waste vaults. While the larger hotels of the city — the Grand Central, American, Delmonico of the West, Alvord, and Wentworth — are probably equal to any five hotels a business city of like size can show, yet the growing requirements — chief among which are a perfect cuisine and large sunny rooms — of the cultivated class of people, constituting the army of incoming invalids, call for a new hotel in Denver such

as will bear comparison with any in America. We are pleased to note that The Windsor, somewhat recently erected, corresponds with the requirements mentioned. It is a magnificent structure of about two hundred and fifty rooms, having elevators and the modern hotel conveniences.

Many travelers prefer to take furnished rooms, and board, *à la française*, at hotels or boarding-houses, a system which has the advantage of insuring a certain amount of daily out-door exercise.

In educational advantages, Denver is second to few cities in the land.[1] The number of pupils taught in the graded and high schools averages 2,000 annually.

A short drive from the heart of the city across the Platte, in North Denver, are Porter's Mineral Baths and Springs, — sulphureous chalybeate waters.[2]

[1] This city is to be the seat of the future University of Denver, a Methodist enterprise of no small pretensions.

[2] See Table.

CHAPTER VI.

ANALYSIS OF THE ATTRIBUTES OF HIGH ALTITUDE CLIMATES.

CONSIDERATION OF ALTITUDE IN THE ABSTRACT. — PROFESSIONAL THEORIES AS TO RESORTS. — TEMPERATURE.

WE have now somewhat superficially reviewed the characteristics of climates of low altitudes, have geographically indicated medium and high altitudes, and have described favored localities in the section which interest us, with their medicinal springs and attractions.

In contrast with the *uncertainties* of low levels we have the *positive* features and effects of elevated regions. The considerable space given to the former, is for the purpose of bringing into prominence the characteristics of the latter, which will not be thought amiss when we reflect how much our appreciation of good comes to us through comparison.

Let us then consider high altitude in the abstract, and seek to analyze the qualities of its atmosphere, leaving, for the present, geographical and local considerations mainly in the background; and, when the facts are in our possession, an idea may be formed of the climates which will best answer the consumptive's needs. True, we cannot fathom the Creator's plans, nor improve on the world He has given us; but having satisfied ourselves of the *ideal* for the majority of phthisical patients, we may then seek the nearest possible approach to it, among the varied climates of the earth.

Here let us remark how various are the theories entertained as to the most beautiful and desirable country in

which to live; "places which have been praised to the skies as perfect El Dorados for invalids are sooner or later abandoned; every nation has its favorite resort, and the most distinguished physicians often hold the most opposite views in regard to the therapeutic value of the same health station."[1] Note, also, the improbability that the medical fraternity would now agree, were they, on the evidence of experience, to vote what would be the best average temperature, humidity, amount of sunshine, electric tension, wind, and elevation, of an ideal climate, for the majority of consumptives or even the simplest phases of the disease.

Indeed, in these separate fields of study, the task of making deductions which shall be generally accepted as conclusive seems at first almost an impossibility.

The attributes of climate just mentioned are so intimately interwoven and dependent upon each other, that their separate consideration is difficult. We will try, however, to avoid repetition by referring to them in the order named, and to seek definite results in the evidences of variously collated facts; remembering always that we are not so much speaking of altitude *per se*, as of altitude as the key to better aero-hygienic conditions.

TEMPERATURE.

The temperature of high altitudes makes life pleasant at the equator, and gives marked variety to climates north and south of that line. In general, the decrease in the temperature of the air has been reckoned at 1° Fahr. for each 300 feet of elevation.[2] But the measure of de-

[1] *An Address delivered before the Austrian Meteorological Society*, by Dr. J. Schreiber, Lecturer on Climatology in the Vienna Faculty.

[2] Under the equator it has been estimated to be 1° Fahr., near sea level, for each 333 feet rise; for each 297 feet at 10,000 feet, and for each 318 feet at 20,000 feet elevation; while recent observations in temperate climates have given the statement of 1° Fahr. for every 400 feet. The records of Mr. Glaisher's balloon ascension indicated different strata of air,

crease of temperature cannot be arbitrary for all elevations because of local peculiarities. For instance, the mean annual temperatures of places along the eastern base of the Rocky Mountains in Colorado are much higher than their elevations would indicate, judging from the records of stations in the same latitudes on the Atlantic coast of the United States. The cause of this is —

First : The far inland position. "The sun's rays passing through the air with but trifling loss, fall on land or on water. The specific heat of land being only one quarter that of water, it both absorbs heat and gives it out more rapidly . . . . consequently the more land the greater is the heat, and the wider the diurnal and yearly amplitudes of fluctuation." [1]

Second : The dry, sandy soil. The plains have few rivers and trees, and are generally but lightly covered with grass. This tends to increase the difference between the above mentioned heat absorbing and radiating qualities of ordinary clay soil and water, and so furnishes both greater absorption of atmospheric moisture and greater radiation of heat, than the ordinary soil of low lands.

Third : The protection afforded by the mountains, to the west and northwest. These break or divert strong winds, and gather moisture from western currents, thus promoting an increase of sunshine on the plains.

Fourth : The dry and warm equatorial and Pacific winds. These prevail at all exposed points on the mountains, and bring pleasant weather to the plains below.

In considering the variations of temperature referred to above, we remark that the more rapid absorption and radiation of heat by land than by water, explains the

the fall in temperature being, under a clear sky, 5° Fahr. for each of the first four inches of barometric fall, then 4° per inch till the thirteenth inch of descent, and 4.5° each for the last three inches.

[1] Parkes, *Practical Hygiene*, p. 417.

low fall of temperature at night, and the considerable rise at midday, away from the sea-coast, and shows, inversely, the *equalizing* influence of moisture in the air on temperature. These variations are increased in high altitudes as the capacity of the air to hold moisture is lessened by rarefaction. The annual fluctuations, due to the changed angles at which the sun's rays fall on the earth, are for the same reason similarly affected by elevation. Thus the following table is explained, giving the mean daily range, the average monthly range, the range of monthly means, the annual means, and the annual range of temperatures of places chosen as nearly as possible in the same latitudes, on the sea-coast, inland, and at the base of the Rocky Mountains.

TABLE VII.

SHOWING RANGES OF TEMPERATURE FROM JULY, 1874, TO JULY, 1875.[1]

	Mean Daily Range.	Mean Monthly Range.	Range of Monthly Means.	Annual Mean.	Annual Range.
ATLANTIC STATIONS.					
New Haven, Conn. . . .	16°[2]	42°	48°	48.6°	91°
Atlantic City, N. J. . . .	15	41+	44.1	49.7	89.5
Baltimore, Md.	18	44	48	53.9	98.5
Norfolk, Va.	18	44	40.7	57.3	89.5
Average	17	43	45.2	52.4	92.5
INLAND STATIONS.					
Davenport, Iowa	18	53.5	68.6	46.8	120
Indianapolis, Ind. . . .	22+	57	68.5	51.7	127.5
St. Louis, Mo.	20	53	57.4	54.2	117
Nashville, Tenn.	21	49	49.7	59.5	108
Average	20+	53.12+	58.55	53.05	118.5
ELEVATED STATIONS.					
Cheyenne, Wyo.	31	61.5	48.9	43.6	136
Denver, Colo.	30	60.5	53.7	49.2	131
Colorado Springs, Colo. . .	30	63.5	47.7	46.8	123
Santa Fé, N. Mex.	29	49.5	45.3	49.2	88
Average	30	58.75	48.9	47.2	119.5
PACIFIC COAST STATIONS.					
San Francisco, Cal. . . .	12+	31	11.5	55.5	50
San Diego, Cal.	13	31	5.6	59.9	60
Average	12.5	31	8.55	57.7	55

[1] *Report of the Chief Signal Officer, War Department*, 1875.

[2] Throughout this work the Fahrenheit thermometer is used.

Besides showing the effect of inland position and elevation on the daily, monthly, and annual ranges of temperature, this table makes evident certain facts of interest both in reference to the stations separately, and the groups into which they are divided.

First. The fluctuations in temperature (notably, of course, in the annual range) decrease towards the South. This continues till even greatly elevated localities, near the equator, are quite equable in temperature, as on the elevated plains in the Peruvian Andes.

Second. The comparatively low range of monthly means, at the "elevated stations," considering the high mean daily, monthly, and annual ranges (with the low average relative humidity of this section, about .45), indicates that there must have been a large proportion of pleasant, even weather at those stations in each month, to have made up for those other extremes. This preponderance of pleasant, sunny weather is quite uniform at the base of the mountains.

Third. The extremely low mean range of temperature for all divisions of time, on the Pacific coast, indicates the existence of an unobstructed, continuous, warm, moist wind, which only yields its moisture when cooled by the winter temperature of that latitude.[1]

The influence of heat on the activity of several functions of the body leads us to prefer a cool to a warm temperature.

[1] It is *unobstructed*, for otherwise there would be greater precipitation of moisture, and accompanying thermal changes. That it only rains in winter, is a fact known to all. It is a *continuous* wind, for otherwise terrestrial radiation and absorption would produce a much more marked effect on the temperature than the records show. It may be considered *warm*, because a cold wind could not carry moisture enough to have produced such thermal effects in these latitudes. It is *moist* because if it was dry the daily and seasonal influences of the sun would be greater than the records show. We are not surprised then to learn that the average atmospheric humidity is out of proportion to the amount of rain-fall on the Pacific coast.

First. Heat is opposed to stimulation so far as the nervous system is concerned. "In experiments on frogs, when a temperature much over the natural amount is applied to nerves, the electrical currents through them are lessened, and at last stop."[1] Observations[2] show that for men the same rule holds good, the most favorable temperature being 99.5° Fahr.[3] Then a difference between the temperature of the surrounding air and that of the body intensifies the influence of atmospheric electricity, which experience proves to be an active agent at considerable elevations.

Second. Heat in the shade has been shown by Rattray,[4] and others to have a sensible effect in increasing the temperature of the body, to counteract which a healthy activity of the skin is required, but this is impeded by a coincident high relative humidity of the air. The experiment of entering an oven heated to 200° or 300° becomes more difficult when the air is moist than when it is dry; evaporation is hindered, and the bodily temperature is said to rise even 7° or 8°.[5]

Third. Heat lessens the number of respirations per minute. According to Rattray's observations, the variation has been known to be from 16.5 respirations per minute in England, in winter, to 12.74 and 13.74 in the tropics. Other observers note that the breathing is also less deep. Dr. Francis of the Bengal army, and Dr. E. A. Parkes,[6] have both observed that the lungs are lighter after death in Europeans in India, than the European

[1] Eckhard, *Henle's Zeitsch.*, Band x., p. 165, 1851.

[2] Weber, *Ludwig's Phys.*, 2d ed., vol. i., p. 126.

[3] Parkes's *Practical Hygiene*, 4th ed., p. 400.

[4] "On the Effects of Change of Climate on the Human Economy," by A. Rattray, M. D., Surgeon R. N. *Proceedings of the Royal Society*, 1869–1872.

[5] By inference we find here one cause of sunstroke, which in our experience does not occur at great elevations in America, notwithstanding that Dr. Vacher (*op. cit.*) speaks of sunstroke occurring on the Alps.

[6] On *Algide Cholera*, by E. A. Parkes, M. D., p. 14 (1847).

standard. On the other hand, a healthful activity of the respiratory function is favored by a cold temperature, and is an important feature of the high altitude cure.

Fourth. Heat, especially if continuous, lessens the digestive power. The stimulation of the appetite which cold is well known to produce, is lacking, especially for much-needed animal food. So the destruction and formation of tissue is retarded. Thus that renovation of the system, which is so essential to health, and which is imperfect in warm climates, is decidedly promoted by a cold temperature.

An important feature of temperature is the relation it has to the quantity of oxygen in any amount of air taken as a standard. There is a loss of oxygen due to the expansion of the air by heat, which compensates, to a great degree, for the loss due to expansion by rarefaction, a process which, as we know, produces a cooler temperature.[1] Lombard estimates that the cooling of the air due to an elevation of 1,600 to 3,000 feet compensates for the loss of oxygen during a great part of the year. This is of the utmost importance as explaining how we get as much oxygen in a cubic foot of air at 3,000 feet elevation with a temperature of 32°, as at sea-level with a temperature of 65°. If there were any greater loss of oxygen by elevation than would be thus compensated for by the cooler temperature natural to the heights, then the increased stimulation of respiration, which is pro-

[1] The difference in weight between dry and saturated air is a matter of some importance, as giving the greater weight and so the more oxygen to the former, the difference being .34 at zero, and 11.28 grains at 100° Fahr. in favor of the dry air. But the greater variation in weight, and so in oxygen, is due to temperature, the weight of a cubic foot of dry air at zero being 606.37 grains, while it is 497.93 grains at 100° Fahr. according to Mr. Glaisher's tables. Here is a difference in the weight of the constituents of the air equal to one fifth of space, all caused by this change in temperature.

duced by cold, might be expected to more than supply the deficit. Besides, it is an important fact cited by Seguin,[1] — and one which might be constantly held before the indifferent consumptive, — that three to four times as much oxygen is consumed in activity as in repose. Then, in climates made stimulating by increased electric tension and cold, activity must be followed by an increased endosmose of oxygen. Thus we have a strong argument in favor of a cool temperature, and an excellent explanation of the reason why the best climatic qualities opposed to consumption are found, at lower elevations, as we go from the equator toward the poles.

The conclusion of our thermometrical observations is well expressed by Dr. Schreiber,[2] that "pulmonary consumption is neither favored by a low temperature, nor prevented or cured by a high one;" a statement borne out by the geographical distribution of the disease. Two instances are cited of very *dry* climates. In Siberia, phthisis is very rare, even among the convicts, who would have succumbed to the disease in their own countries. At Nijni-Rolimsk, 68½° north latitude, within the line of perpetual congelation of the soil, where the average temperature for spring and autumn is about 18° Fahr., — to say nothing of winter, — consumption is unknown.[3] On the other hand, Dr. Snepp, of Alexandria, tells us that in Cairo, Egypt, consumption is a common disease.

[1] *Traité de Climatologie Médicale*, par le Dr. H. G. Lombard, de Genéve, Paris, 1877, p. 269, Tome i.

[2] *Address before Austrian Meteorological Society.*

[3] Lombard, *op. cit.*, Tome ii.

CHAPTER VII.

HUMIDITY.

RELATIVE AND REAL HUMIDITY. — ABSOLUTE HUMIDITY THE CRITERION. — THE AIR HOLDS MOISTURE ACCORDING TO TEMPERATURE. — COMPARISON OF CLIMATES. — THE KIRGHEEZ STEPPES. — ASTRACHAN. — COOL, DRY CLIMATES.

"L'humidité augment le nombre des phthisiques, tandis que la sécheresse le diminue." — LOMBARD.

To continue our argument that *cool dry* climates are better adapted to the needs of phthisical patients, let us consider the humidity of the air, bearing in mind that coolness and dryness are constantly favored by increasing elevation. This brings us to one of the strongest proofs in favor of high altitudes. It is difficult, however, to thoroughly explain this subject because of our lack of familiarity with the precise laws which govern the various changes of the moisture of the air.

The Signal Service Bureau of the U. S. army determines the percentage of saturation — or relative humidity — of the air by the difference in temperatures given by the wet and dry bulb thermometers. But these humidity records have not been well distributed, and it would seem, either that the officers of this bureau have little confidence in the reliability of humidity statistics, or that they do not appreciate their important bearings on climatological investigation. While the relative amount of atmospheric moisture is important, as determining the healthful activity of the skin, the promotion of perspiration and its evaporation from the surface of the body being proportionate to changes in the dew-point, and to

the removal of the temperature of the air from that of the body, — yet these records are in a great measure superficial, because they are *relative* and not *real*. This, too, notwithstanding this relative ratio of saturation, is only a little more than half as much on the dry plains east of the Rocky Mountains as in some localities on the sea-coast. In the lower moist districts this percentage often reaches saturation, — the point at which fogs and dews are produced, — as a natural condition; while on the western plateaus the habitually lower ratios present proof enough that the temperature is rarely found in the suspicious company of the dew-point.

Such, I believe, is the importance of a large amount of atmospheric vapor as a *causative*, and of a small amount as a *curative* element of phthisis, that the *absolute* rather than the *relative* amount of moisture in the air claims our special study. If we knew, to-day, the absolute humidity — or the average amount of vapor in a cubic foot of air — in all parts of the country, we should have one of the most valuable indications possible of the best localities for phthisical patients. With some reservation as to temperature, the smallest ratios would indicate where consumption seldom originates. In such localities there must be a low ratio of relative humidity, small annual rain-fall, — except sudden and great precipitations, — a large proportion of sunshine, and a favorable diathermancy of the air, so much do these happy conditions accompany real dryness of the atmosphere. This absolute humidity would of course be shown to be greatest in the tropics, least toward the poles; increased over large bodies of water, decreased as we go inland; increased by heat, as in summer and at midday, and decreased by low temperature, as in winter and in the morning.

To thoroughly appreciate the importance of the real atmospheric humidity, it is to be observed that the air

is capable of holding moisture, mainly according to its temperature. The expansion of air under the influence of heat increases its capacity for retaining invisible vapor from about half a grain in a cubic foot, — the limit at zero, with a barometrical pressure of thirty inches, — to 19.84 grains, the limit at 100° Fahr.

TABLE VIII. (GLAISHER'S.)

SHOWING WEIGHT OF VAPOR, IN GRAINS TROY, CONTAINED IN A CUBIC FOOT OF SATURATED AIR, AT TEMPERATURES BETWEEN ZERO AND 105° FAHRENHEIT.[1]

Temperature of Air, Fahr.	Weight of Vapor in Grains.	Temperature of Air, Fahr.	Weight of Vapor in Grains.	Temperature of Air, Fahr.	Weight of Vapor in Grains.
0°	0.545	45°	3.426	81°	11.291
4	0.649	48	3.811	84	12.376
8	0.772	51	4.234	87	13.546
12	0.916	54	4.696	90	14.810
16	1.090	57	5.202	93	16.176
20	1.298	60	5.756	96	17.648
26	1.674	63	6.361	99	19.235
29	1.892	66	7.021	101	20.357
33	2.208	69	7.739	103	21.535
36	2.469	72	8.521	105	22.771
39	2.759	75	9.372		
42	3.076	78	10.292		

As to a loss due to change in the weight of the air, many complications present themselves, among which, a very slight one, is the fact that dry air weighs from two grains (at a temperature of 44° Fahr.) to eight grains (at 80° Fahr.) more in the cubic foot than saturated air.[1] The elastic force of vapor, or the absolute humidity of the atmosphere, Mr. Buchan says, "diminishes with the height, but the average rate at which it diminishes is not known."[2] The records of balloon ascensions give some interesting though indefinite information in this direction. The balloonist Croce-Spinelli, who perished in his aerial flight, recorded that, at an elevation of 16,370 feet, "there was no longer vapor in the air;" and the experience of many of us who have ascended

[1] *Smithsonian Meteorological and Physical Tables*, by A. Guyot.

[2] *Handbook of Meteorology*, by Alexander Buchan, p. 162.

great heights, agrees with that of Gay-Lussac, who recorded in his balloon ascension that, at 14,715 feet, "the air was so dry that for want of saliva he could hardly swallow bread."

We understand that the air is twice as rarefied at the height of three and one half miles, as at sea level, four times at seven miles, sixteen times at fourteen miles, sixty-four times at twenty-one miles elevation, etc. This expansion of the air with increasing elevation is accompanied by a loss of part of its humid contents, through the coincident cooling which takes place, so plainly described by Professor Tyndall.[1] If we follow a cubic foot of saturated air in its ascent through space, we notice the loss of most of its moisture in consequence of chilling due to the expansion; but there is another portion of the moisture, as well as of the air, crowded outside the cube by the same expansion.

Glaisher's tables, before referred to, which give the weight of vapor in a cubic foot of saturated air at different temperatures, are made for a barometric pressure of thirty inches. If these tables are as accurate for places a mile up in the air as for those at sea level, then there is no diminution of moisture due to elevation independent of temperature, and the saturated air of such height may retain more moisture in proportion to its weight for a given temperature than the air at sea level. The air at the School of Mines, in Golden, Colorado, 5,900 feet above sea level, was found by Prof. E. J. Mallett to contain at 60° Fahr. 331 grains of nitrogen and 99 grains of oxygen, or 430 grains weight for the cubic foot, which is just about four fifths the weight of air at sea level.

Is there no diminution in the capacity of this rarefied air for moisture, due to the lessened pressure of three pounds to the square inch? The question is of impor-

[1] *The Forms of Water*, by John Tyndall, LL. D., F. R. S., 1874.

tance to us as affecting the basis of our judgment of high altitudes. Besides, the Signal Service weather reports come to us with relative humidity noted as "not corrected for elevation," and we are left to learn what such correction may be. Now avoiding the perplexity induced by the search for suitable explanations in Guyot's and Glaisher's complicated tables, we will simply say that the only correction given is by the former author,[1] and adds from two to three per cent. to the relative humidity of places of the altitude of the Rocky Mountain base. This correction, as affecting the dryness of air in high altitudes, amounts to but little; besides, as we have shown, the comparison of climates by the *relative humidity* of each, is superficial, when temperature is not taken into account.

With temperature, however, as indicating the capacity for moisture, I have computed the actual increase due to the elevation of Denver, in grains of moisture, per cubic foot of air, to be about as follows: .08 in winter, .13 in spring, .21 in summer, .12 in autumn, and .13 for the year. Thus having the precise addition claimed for this elevation, the question naturally recurs in this form: Is the comparison of climates by the *absolute humidity* of each just? Let us suppose that it is so, and, adding Guyot's corrections, make one or two comparisons, which will suffice to show the superiority of the highlands over the lowlands.

We are enabled to compute the weight of vapor from Glaisher's Table already given, or from one of Guyot's tables. Compare New Orleans, La., Jacksonville, Fla., Santa Barbara, Cal., with Denver. According to Dr. Baldwin,[2] the mean annual temperature of Jacksonville is 70°, and the mean relative humidity .69+. Dr. Dimmick, of Santa Barbara, gives the mean annual relative

[1] *Smithsonian Meteorological and Physical Tables*, p. 72.

[2] *An Address on Climatology of Florida*, by A. S. Baldwin, M. D.

humidity of that place as .69 +, and of New Orleans, .83 +; the annual temperatures being respectively 61° and 69.5°. The Signal Service records of Denver give a mean annual temperature of 49.2°, the relative humidity being .46. Now making correction for the height of Denver, these figures show 6.58 grains of vapor in the average cubic foot of air in New Orleans, 5.6 in Jacksonville, 4.23 in Santa Barbara, while in Denver the amount contained is 1.91 grains. Thus the latter is shown to have about one third the atmospheric moisture of New Orleans and Jacksonville, and less than half that of Santa Barbara.

Again, compare the humidity of New Orleans, Santa Barbara, Jacksonville, Philadelphia, Davos (Switzerland), and Denver, for the five cold months ending with March, the term of the *air-cure* at Davos, we have: —

TABLE IX.

	Elevation.	Mean Temperature.	Mean Relative Humidity.	Grains of Vapor in a Cubic Foot.
New Orleans	– –	61°	.68	5.11
Santa Barbara	– –	56	.69	3.98
Jacksonville	– –	60	.68	3.92
Philadelphia	– –	37	.83	2.35
Davos	5,200	23	.85	1.24[1]
Denver	5,200	33	.51	1.13[1]

The small amount of absolute humidity, compared with the high relative humidity of Davos shows the fallacy of judging solely by the relative humidity, while the whole table proves the remarkable dryness of high altitudes in winter, and renders the claims of Santa Barbara, as a dry health-station, doubtful.

The physical effect of cold, with excessive *absolute*, as opposed to a high ratio of *relative* humidity, with really little moisture, is considerable. A gentleman, now a

[1] Corrected for barometrical heights by Guyot's *Meteorological Tables*, p. 72.

resident of Denver, who formerly resided in Jacksonville, says that he "stands the winter cold better, and feels less chilly in Colorado than in Florida;" and the temperature of 58°, in doors, which is always very comfortable in Denver, is said by Professor Walshe to be disagreeably chilly at Madeira. Except certain high altitudes, where mountains act as constant condensers of moist currents, it is now incontestably shown that, as to temperature and humidity, coolness and dryness are progressively concomitants of increasing elevation.

We find corroborative evidence of the favorable influence of dryness, irrespective of altitude, in the fact that, among the nomads of the Kirgheez Steppes, dry, arid plains north and east of the Caspian Sea, consumption is unknown; while at Astrachan, situated on a delta formed by the Volga as it empties into the Caspian Sea, half the deaths, during the summer season, are occasioned by this disease.[1] The Kirgheez Steppes and Astrachan are both below the level of the ocean,

The argument, then, that cool, dry climates, or high altitudes, are better than warm, moist ones, or tropical lowlands, needs no better conclusion than the evidence furnished by Dr. C. T. Williams's excellent analysis of 593 winters spent by 251 consumptive patients in foreign climates. I quote with pleasure — with thanks for the unintentional favor — the indisputable evidence this zealous student of European and lowland resorts gives for high altitudes. I have already adverted to the experience of 243 consumptives who spent 386 winters in English home stations, which resulted in the colder resorts "bearing off the palm." Now as to the experience in foreign climates, Dr. Williams concludes: "As to what class of patients profit most by dry climates, it has been shown that, taking collectively all forms and degrees of phthisis, the dry climates are the most likely to

[1] Lombard, *Traité de Climatologie Médicale.*

arrest the disease. . . . . As to the desirability of moist climates for consumptive patients, the evidence is decidedly against their use in the treatment of ordinary chronic phthisis. The addition of warmth only makes the damp tell more unfavorably, though a strong saline element and invigorating breezes do something to counteract the humid influence. Still even these do not place a moist climate on the same level as a dry one." [1]

[1] *Lettsomian Lectures.*

CHAPTER VIII.

DIATHERMANCY [1] OF THE AIR.

CLEARNESS OF THE AIR IN COLORADO. — TABLES SHOWING DIATHERMANCY. — TABLE SHOWING DIFFERENCE IN ELEVATION FOR EACH DEGREE OF DIATHERMANCY. — EFFECT UPON RADIATION. — BENEFICIAL EFFECTS OF SUNSHINE INCREASED WITH ALTITUDE. — THERAPEUTIC VALUE OF LIGHT AND SUNSHINE.

A STRIKING, and to most people a novel feature of high altitudes, is the clearness of the air, as shown by the intensity of the sunshine. I was impressed with this characteristic on my first arrival in Colorado, when, driving towards the northeast on a cold winter afternoon, the exposed portions of my body became chilled, while the back of the carriage-seat, on which the sun was shining, was very hot. After ineffectually endeavoring to get the Signal Service officers to study this matter, I conceived the idea of determining for myself the ratio of difference between the temperature in sunshine and shade, for each decided elevation, believing that, with the same conditions, excluding the influence of the wind, artificial heat, etc., observations at a few stations would serve to establish an approximate rule for almost all elevations. Accordingly, the desired temperatures were recorded at Washington, D. C., at Royalton, Vt., and at Denver. Ordinary thermometers in metallic frames, and of Fahrenheit scale, were used; the observations were taken at 2 P. M. on clear days only, and western rooms, with western windows, not artificially heated, were chosen. The temperature of the room was taken in the shade and in the sun, with the window closed and with

[1] The increased facility with which radiant heat is transmitted.

it open, the direction, etc., of the wind being noted, the idea being to exclude observations perceptibly influenced by wind and partial clouds. The results must be taken as only approximate for general conclusions, on account of the conditions by which they may have been affected, the fewness of the stations, and the short time the observations continued, extending only over parts of March, April, May, and June.[1] I found an average of the same kind, taken at the city of Mexico by Dr. Jourdanet,[2] which is added to the accompanying table: —

TABLE X.

SHOWING DIATHERMANCY OF THE AIR.

Stations.	Elevation above Sea.	Difference between Temperature in Sun and Shade In-doors, Window Shut; from	Average Difference.	Ditto, Window open or Out-doors, the Windy Days excluded; from	Average Difference.
Washington, D. C. .	80 feet.	12° to 37°	23°	17° to 37°	25°
Royalton, Vt. . . .	500 feet.	16 to 42	27	23 to 47	28
Denver, Colo. . . .	5,200 feet.	40 to 48	43	46 to 55	50
Mexico, Mex. . . .	7,660 feet.	- -	-	56 to 65	60[3]

Besides the increase of diathermancy, the table shows the more uniform clearness of the air at high than at low altitudes. From this table we may nearly reach the desired result, namely the difference between sun and shade, or the heating power of the sun's rays. C. S. Richardson, C. M. E., kindly took many observations for me, at the Dolly Varden mine, on Mt. Bross, Colorado, which

[1] Lately I have been pleased to learn, from Dr. Vacher's brochure on "Davos, Le Mont Dore," that others also have been making observations similar to my own. But as these observations, one with the thermometer *in vacuo*, and another, that of M. Saussure, which consisted in "exposing to the rays of the sun a thermometer placed in a wooden box, lined with black cloth and covered with glass," were not made under conditions favorable and usual to human existence, I have more confidence in the utility of my own; though the contrasts between sunshine and shade are not as great in my observations as in the others.

[2] *Le Mexique et l'Amérique tropicale.* [3] Taken in January.

showed a difference of only 10° to 20° between the temperature in the sun and in the shade, out-doors at 2 P. M. and did not indicate the real diathermancy of the air. This I attributed to the rapid radiation of heat and constantly moving cold air of that exposed place. As there was no suitable building in which to try the other test, I prepared pasteboard boxes, with glass covers, and with black velvet lining, in which were taken the temperatures at Denver, Alma, and on Mt. Bross, at 2 P. M. for a few days, at nearly the same season, with a result as follows: —

TABLE XI

SHOWING DIATHERMANCY.

Stations.	Elevation above Sea.	Temperature in Shade.	Temperature in closed Box with Glass Cover (Sunshine).	Difference.
Mount Bross, Col. . .	13,400 feet.	56°	162°	106°
Alma, Colo.	8,800 feet.	68	154	86
Denver, Colo.	5,200 feet.	88	160	72

The differences between these records and the temperatures in the shade, noted at the same time, serve to show the increasing diathermancy of the air at these greater elevations, notwithstanding the peculiar influence of the cold air and wind of those heights. Now the differences between these diathermancy tests tally as in Table XII. with the given differences in elevation.

Thus a general rule is evolved, which may be changed by more accurate and extended observations, of *one degree greater difference between the temperature in sun and shade for each rise of 235 feet.*[1]

This diathermancy explains as clearly as does the absolute humidity of the air, the daily fluctuations in temperature so gradually augmented with increasing eleva-

[1] This is the first time, so far as I am aware, that a definite scale for this change due to elevation has been stated.

tion. But the transparency of the air is mainly explained by the absolute humidity, or elastic force of vapor, the elevation giving only an increase in diathermancy above that produced by the decreasing humidity. So dry, low places, like Fort Yuma, California, will be exceptions to the rule given. However, this does not disprove, but, on the contrary tends to establish the increased diathermancy of high altitudes, where, as we have already shown, there exists a considerably lessened absolute humidity.

TABLE XII.

SHOWING DIFFERENCE IN ELEVATION FOR ONE DEGREE OF DIATHERMANCY.

Stations.	Difference in Elevation.	Average Difference in Diathermancy.	Average Difference in Elevation for one Degree of Diathermancy.
Washington and Denver	5,120 feet.	23°	223 feet.
Washington and City of Mexico . . .	7,600 feet.	35	217 feet.
Royalton and Denver	4,700 feet.	20	235 feet.
Royalton and City of Mexico	7,160 feet.	32	224 feet.
Denver and City of Mexico	2,460 feet.	10	246 feet.
Denver and Mount Bross	8,300 feet.	34	424 feet.
Denver and Alma	3,600 feet.	14	257 feet.
Alma and Mount Bross	4,700 feet.	20	235 feet.
Average	- -	-	235 feet.

The effect of this diathermancy of high altitudes on solar and terrestrial radiation is wonderful. The solar radiation is rapid, and soon after sunrise the temperature rises, because of the slight resistance which the rarefied and dry air offers to the sun's rays; while, after sunset, the terrestrial radiation is also rapid, because there is no moist envelope shrouding the face of the earth to prevent the natural cooling of the dry ground.[1] This is exemplified in the warmth of the sunshine in the early

[1] The character of the sunlight of high altitudes is a nearer approach, if possible, to white light, than at sea level, and many find it desirable to wear gray-blue or smoked glasses to neutralize its effect.

morning, and, again by the returning coolness at the close of day, when the solar influence as suddenly disappears, so that within an hour or two there is a marked cooling of the atmosphere, — change almost like the decided difference between sunshine and shade given in Table X.

The conclusion of this evidence is as follows: Comparing the effects inimical to life in mines, cellars, and ill-lighted abodes, with the benefits of sunlight at low levels, where a stratum of moisture intercepts the sun's rays like a thin cloud, and then with the healthful influence of the unobstructed sunshine of the highlands, and we can say, without fear of successful contradiction, that *the beneficial effects of sunshine increase with increasing altitude.*

It is further to be noted, that the sun's rays being less obstructed by clouds over such plains as those east of the Rocky Mountains, there is a proportionately *longer* influence of sunshine in each twenty-four hours. According to the records in the Signal Service Office at Denver, there were only seventeen days from January 1, 1873, to September, 1878, in which the sun was invisible throughout the whole day.

This same diathermancy, associated, as it is, with more rapid radiation after sunset in elevated regions, explains a certain degree of incorrectness of the ordinary temperature records of the Signal Service, which I have not hitherto seen noticed. These records are taken in the shade, and usually, as in Denver, on the north side of the building, with the cold nine o'clock observation doubled and added to the seven A. M. and two P. M. observation, and the whole divided by four to give the general average. So, one warm midday observation is made to balance three almost wholly uninfluenced by the daily heat from the sun. We are much warmer on the elevated western plains, during the hours

in which life out-doors is desirable, than is indicated by the thermometrical records.

The therapeutic value of light and sunshine is, unfortunately, too little understood or appreciated. Lombard tells us that *light — lumière — stimulates and darkness impedes respiration*, and through respiration, of course, animal heat and muscular activity. Moleschott proved this fact by experiments upon himself; and the scientists, Bidder and Schmidt, noticing that animals, at rest, produced more carbonic acid in the day-time than at night, equalized the amount by depriving them of the influence of light.[1] The experiment of consumptives, some sixteen in all, seeking reputed benefit from the equable temperature of Mammoth Cave, Kentucky, resulted, of course, in failure; five dying within a short time, and others being injured, a result due, undoubtedly to the darkness and dampness combined. An inquiry, in reference to this point, reveals the fact that in hospitals and barracks, the mortality upon the shady side of the building far exceeds that upon the sunny side. While winter experience in high altitudes with consumptives, proves to my own knowledge, that these patients improve the most in large airy rooms with a bright, sunny exposure.

[1] *Op. cit.*, Tome I., p. 221.

CHAPTER IX.

ATMOSPHERIC ELECTRICITY. — OZONE AND WINDS.

CURATIVE INFLUENCE OF ATMOSPHERIC ELECTRICITY. — CIVILIZATION TRAMMELS PHYSICAL DEVELOPMENT. — AN OUT-DOOR LIFE. — SLEEPING ON THE GROUND. — ELECTRICITY OF HIGH ALTITUDES. — OZONE. — IMPERFECTION OF SCHÖNBEIN'S TEST. — OZONE ON THE HEIGHTS. — OZONE AMONG THE PINES. — EFFICACY OF OZONIZED AIR. — WINDS.

"L'électricité et l'ozone agissent sans doute dans le même sens que le froid ; c'est-a-dire, qu'ils stimulent l'activité musculaire." — LOMBARD.

THE importance of atmospheric electricity as a curative power in disease is not to be measured by the little we know about the element itself. The experience in high altitudes of persons of susceptible nervous temperament goes to substantiate the universal evidence of science that, as a rule, electric tension in the atmosphere is increased with each decided elevation. Aside from the change in electric tension and the negative quality of atmospheric electricity during storms,[1] we learn from extended observations,[2] that with a clear sky the electricity of the air is always positive, which quality Alexander Buchan says becomes manifest on flat ground at a height of five feet. It would seem that, with the increase of tension due to elevation, the positive electricity of the air, so abundant in dry elevated regions, would be constantly nearing the negative electricity of the earth. With no other evidence to prove this than the

[1] This quality of storm areas may yet be made to account, to a certain extent, for the benefit to be derived from daily showers in dry weather, these frequent changes of the electric conditions of the air having a decided influence in debilitated states of the human body.

[2] Taken at Kew Observatory.

experience of our nervous systems as we ascend into electrified strata, and the frequency of electrical phenomena there witnessed, I shall incline to the opinion that this is the true state of electric tension of high altitudes, till evidence is produced to the contrary.

Now here is important teaching for the consumptive multitude, in fact for most of the human family. The houses in which we live, and the piazzas and trees under which we sit, are intercepting this vital fluid which we were evidently intended to utilize more than we do. This reflection gives rise to an interesting train of thought in regard to the tendency of civilization towards physical decadence. The revelations of the future, by showing us that every disease is but the infraction of some natural law, may further prove that we were not created to live in the kind of habitations we occupy, and that we violate one of nature's edicts when we immure ourselves in dwellings which exclude any of the vital elements upon which we live. The conception and realization of this make us long for something like the nomadic life of the Israelite, or Arabian, especially when we contemplate the fact of the increasing number of deaths from consumption, which accompany increasing civilization, as evidenced by the last three census reports of the United States.

High altitude experience goes far towards strengthening the common-sense idea that an *out-door life* is of the greatest importance to the consumptive everywhere. The continued mediumship of the human body between the *negative* ground and the *positive* air, whether one is on foot or on horseback, is a constant renewal of his vitality. Here is the secret of the great utility of camping out and "roughing it," in dry, elevated countries. You lie down to sleep on the ground, as only a tired camper can, and rise in the morning from your *negative electric* bed, to stretch yourself in the *positive electric* air. I

have yet to meet with an experience which will dissuade me from advising a consumptive to live in the open air, and sleep on the ground, *whenever conditions are favorable for so doing.*

Dr. James Henry Bennett, whose personal experience with phthisical invalids entitles his opinion to great consideration, thus emphasizes the importance of defective vital or nervous power as a cause of pulmonary consumption, which cause even underlies "the most minute anatomical and histological researches." "Clinical observation shows that the manifestation of these forms of lung disease, chronic and acute, must be looked upon as the evidence and result of a serious, perhaps final, diminution of vital or nervous energy. . . . . Unless the vitality of the individual can be roused, the morbid condition will surely progress, and life will be extinguished sooner or later, according to the state of the constitution of the patient, and to the type of the disease." [1]

A continued study of consumptives' lives in this climate, including the influence of inheritance, would add many facts corroborative of the soundness of this reasoning. But without entering further into details, we may confidently affirm what is abundantly substantiated by experience, that *the increased electrical influence of high-altitude atmosphere is one of our most important aids in the successful battle against consumption.*[2]

Ozone. — In connection with the atmospheric electricity of high altitudes should be mentioned ozone, an important product of that element. "The nature of ozone has been experimentally demonstrated by Rive and Marignac, who have transformed pure, dry oxygen into ozone by electricity. These scientists, therefore, whose names alone are authoritative, proposed to substitute the

[1] *Pulmonary Consumption*, by James Henry Bennett, M. D.

[2] Some further remarks by the author on this subject may be found in *The Archives of Electrology and Neurology*, for November, 1874: "The Influence of the Climate of Colorado on the Nervous System."

name *electrified oxygen* for that of ozone."[1] While we here learn that ozone can exist in perfectly dry air, it remains yet to be proven that Schönbein's test — the starch and iodide of potassium paper used — can give an estimate of ozone with absolute dryness coexisting. It is reasonable, then, to doubt the use of this chemical test, evidently operating, as it does, through the agency of some atmospheric moisture. This being proven partially true, the increased approach to absolute dryness of the atmosphere with increasing elevation, — together with other and local liabilities to error, — renders ozone statistics less and less reliable; the question of their accuracy may be as *relative* as that of the humidity of the air. We must look to the genius of an Edison, or other scientific inventor, for an infallible test of this valuable agent, commensurate with the varying conditions which the broad question of climate involves.

But from the tests which I have had made on the western plains and in mountains, the usual increase of ozone in the mountains is shown, while on the plains there is a good proportion, considering the lack of moisture and distance from the sea. A variation in the amounts observed may, I think, serve as a profitable indication of the special advantage of living in the mountains during the heat of summer. It is this, that the excess noted during the spring months on the plains came proportionately later in the season the higher up the observations were made. This advantage of going into yet higher regions in summer is in consonance with the increased benefit of the cooler temperature which we have already shown elevation insures. Dr. Schreiber, of Vienna, tells us that the turpentine exhaled from pine forests possesses, to a greater degree than all other bodies, the property of converting the oxygen of the air into ozone.[2] If

[1] Lombard, *Traité de Climatologie Médicale*, Tome i., p. 7.

[2] *Address before Austrian Metereological Society.*

this be true, it will explain why a residence among the balsamic odors of the pines has long been esteemed of benefit to the pulmonary invalid.

We have to consider ozone an important element in the atmosphere of a health station, because, considered as an excess of oxygen, by its very presence, pure air may be inferred as existing. This inference naturally follows a recognition of its powerful influence as an oxidizing disinfectant. This it possesses, as Dr. Day, of London, remarks, through its "power of resolving and decomposing all animal and vegetable putrescent matter into primitive and innocuous forms. A stream of ozone, passed through a mass of black, offensive, and putrescent blood, effects a change in it as if by magic; immediately, as soon as the operation has commenced, all disagreeable odor is removed, it reassumes its florid, red color, and coagulation is restored. If ozone be diffused through apartments or elsewhere, it not only disinfects by removing noxious vapors and poison germs, whatever their character may be, but, being itself in the gaseous form, it is inhaled during respiration, and, passing into the blood through the lungs, it oxidizes the used-up and effete matters produced during assimilation and the renewal of various tissues, thus effecting a certain resistance to these pernicious influences if retained within the human body."[1]

Winds. — While but little can be said of the winds of high altitudes, independent of local peculiarities, three general facts may be mentioned, which will not be considered detrimental to elevated climates, in view of the generally admitted healthful influence of a moderate amount of wind.

First. The total movement of the air at nearly all exposed high altitudes, is greater than that at similar places in the lowlands, yet not nearly as much so, at

[1] *Address before the Sanitary Institute of Great Britain and Ireland.*

many points, as would generally be expected. The number of observations in regard to these winds which usually bring mild and pleasant weather, and the total movement of the air,[1] compare most favorably with the records of low altitude stations.

Second. The winds of high altitudes being less diverted from their general course, their indication as to the character of the weather is more constant than at most low stations, and especially is this the case of inland localities. For instance, according to excellent charts in the "Annual Report of the Signal Service Bureau for 1876," giving wind directions which are most, and those which are least likely to be followed by rain, the indications are very strong for Northern and Eastern Colorado, and Southeastern Wyoming, — Denver and Cheyenne — that the south, southwest, and west winds bring pleasant weather, while their opposites, the north, northeast, and east, bring most of the rainy weather.[2] In Eastern New Mexico — Santa Fé — nearly the opposite rule holds good: the northwest, north, and northeast winds bring pleasant weather, while the southeast, south, and southwest winds bring most of the rain. The damp atmosphere comes in both cases from below, — the Missouri Valley and the Gulf of Mexico, — while the dry, warm air comes from over the mountains, which seem to act as condensers. This is proved by the records of the Pike's Peak station, where the rain-bearing winds are the same, as to direction, as the above-mentioned dry winds in the plains.

Third. The winds of high altitudes, while they have the same influence in purifying the air, have proportionately less force, — rapidity being the same, — according

[1] Plate X., "Total Movement of Air, with Resultants," *Statistical Atlas of United States from Ninth Census of 1870*, by F. A. Walker, M. A. See, also, *Climatic Map*.

[2] See *Climatic Map*, page 26.

to the lessened weight of the air due to elevation. It may be said, however, that in dry regions, as the Eastern Rocky Mountain slope, and especially where the adobe soil of New Mexico, Southern Colorado, and Western Texas exists, the dust storms raised by strong winds are a disagreeable element that should be for a time avoided by those having weak or diseased lungs.

CHAPTER X.

ALTITUDE.

PHYSIOLOGICAL EFFECTS OF HIGH ALTITUDES. — THE PULSE AFFECTED BY ELEVATION. — BY EXERCISE. — RESPIRATION AFFECTED BY ELEVATION. — JOURDANET'S THEORY. — MORE PERFECT OXYGENATION ON THE HEIGHTS. — M. PAUL BERT'S EXPERIMENTS. — ANÆMIA. — DEEPER AND MORE FREQUENT RESPIRATIONS. — THE ENDOSMOSE OF OXYGEN FAVORED.

THE physiological effects of high altitude on man are well understood when we consider the lessened pressure of the air which obtains at a given elevation. Reckoning the superficial area of a man's body as sixteen square feet, and the pressure to the square inch as three pounds less at the base of the Rocky Mountains (6,000 feet) than at sea level, we have this surface relieved of the enormous weight of nearly 7,000 pounds. With these figures in our minds we are struck with the wonderful adaptability of the normal human organism to changes in atmospheric pressure, when the limit of danger lies in an atmosphere almost twice rarefied on the one hand and five times condensed on the other.[1]

But when we go further, and learn that Leiberkühn[2] has computed the area of respiratory surface in both lungs of man to be 1,400 square feet, which Dalton avers is not exaggerated,[3] we find a subtraction of pressure from these organs which is truly wonderful, even for an elevation of one mile. The respiratory organs, then, are those which are chiefly influenced by lessened at-

[1] Parkes, *Practical Hygiene*, 4th ed., p. 409.
[2] Simon's *Chemistry of Man*, Phil. ed., 1846, p. 109.
[3] *Human Physiology*, by J. C. Dalton, M. D., 3d ed., p. 236.

mospheric pressure, the effect on other organs being mainly secondary to the induced activity of respiration.

Let us analyze the *modus operandi* of this phenomenon. The proportions of oxygen, nitrogen, and carbonic acid, to each other, do not vary greatly for habitable elevations. With temperature remaining unchanged, there is then a fifth less oxygen in a given space of air a fifth rarefied, as at 6,000 feet. So it seems the lungs must inspire a fifth more air to get the same amount of oxygen than at sea level. This greater work is accomplished, first, by quickened respiration, which, as well as the coincident increased activity of the heart is best shown in aeronauts who make no muscular exertion as they rise.[1] Dr. Vacher says that M. Gaston Tessandier, the surviving aeronaut on the Zenith, gave him the record of his respirations as 26 at 17,331 feet, and on the earth 19 to 23 per minute. Dr. Vacher himself, when he went to investigate the remarkable effect of the winter air cure (cures d'air), at Davos, made careful estimates of his respirations, which were 18.2 per minute at Davos, while at Paris they were 16.6, his pulse increasing from 69 to 78 beats per minute.[2] When I came to Colorado seven years ago, I noticed an increase in my respirations from about 20 to 30 per minute, in twenty-four hours, while rising 4,000 feet in Western Kansas, and an increase of pulsations from 72 to 82.[3]

By comparing a number of estimates of the pulse

[1] *Balloon Ascents*, by Parkes. Biot and Gay Lussac, at 9,000 feet, increase of 18 to 20 beats of the pulse. Glaisher, at 17,000 feet, increase of 10 to 24 beats of the pulse. Glaisher, at 24,000 feet, increase of 24 to 31 beats of the pulse.

[2] *Le Mont Dore-Davos. Étude Médicale et Climatologique*, etc.

[3] This record is of use, as compared with that of Dr. Vacher, who was probably in health, to show the increased disturbance elevation favors in those whose lungs are impaired; for at that time, ten months after pulmonary hemorrhages, my right apex and some other peripheral lung tissue showed signs of being clogged with inflammatory or other products, which have since happily disappeared.

taken by Dr. Hermann Weber, by aeronauts, and by myself and others, for the purpose of discovering the influence of elevation upon the same, and having the records made with similar positions of the body, conditions of rest, etc., we may approximate a general rule for the *increase of the pulse for a given rise in elevation.* This scale I will fix at one to two pulsations per minute for each 1,000 feet rise in the case of healthy persons, who are unaccustomed to the influence of the heights, the records for different elevations being taken within the same twenty-four hours. Any estimate, however, will vary so much with different persons and circumstances, that a scale without latitude of reckoning would be the exception rather than the rule. How variously different circulations are affected by increase of elevations is made evident by noting the different susceptibilities of nervous systems, the influence of age, sex, weight, former habits of exercise, already existing internal organic disease, old pleuritic adhesions, or even weakness in respiratory power.

The influence of prolonged or violent exercise, as in climbing high mountains, may exaggerate the effect just noted, to such a degree as to preclude the possibility of any definite estimate without burdensome detail, — an effect which continues sometimes for half a day or more, — illustrated by the case of Weber, who noted that his pulse remained, for several hours, some ten to twenty beats higher after, than before, a forced ascent of one of the Alps; while the pulse of his guide, who was accustomed to that life, retained to a considerable extent its equability.

As to respiration, the exercise of the will makes a great difference in its frequency. Besides, the respirations in high altitudes are more generally increased in frequency by muscular exertion than in low countries, as any member of an Alpine Club can testify. An inti-

mate relation between the rapidity of respiration and increase of heart beats is to be noticed in mountain life. Lungs of persons habitually active in high altitudes, have little incentive to frequent respiration when the individual is perfectly quiet, as is usual when the respirations are counted.

I thought I discovered another of the immediate effects of elevation, which I have nowhere seen mentioned, but which yet may be of account in studying the therapeutics of the high-altitude cure of phthisis, an early and almost constant symptom of which disease is *prolonged expiration*. I refer to a quicker expiration, which was as though the increased number of respirations per minute was made up from the time given to expiration.[1]

As to the effect of altitude on breathing, Dr. Vacher takes issue with Dr. Spengler, of Davos, and also with Dr. Jourdanet, — the two latter gentlemen claiming that "the lungs supply a deficiency of oxygen by deeper and slower," while the former emphasizes the "more frequent," respirations.

I shall have to differ with these gentlemen on both sides — especially Jourdanet — saying the respirations are both deeper and more frequent, at first the *frequency*, and afterwards the *profundity* predominating. According to Coindet, who made 1,500 observations of the frequency of respirations in France and Mexico, they were 19.36 per minute for the French, and 20.30 for the Mexicans. The greater breadth of the lungs of inhabitants of high altitudes has been noted by all observers who have had favorable opportunities for testing the question. Our knowledge of the mountain Indians of the western part of the United States agrees with the fact noted by Jourdanet, "that Mexican Indians, though

[1] "Colorado as a Winter Resort for Invalids." *Chicago Medical Examiner*, January 15, 1874

medium height, have unusually large and wide chests, te out of proportion to their size." Even children, n in the Rocky Mountains, have been noticed to have sts of unusually large capacity, and the increased cumference of the chests of consumptives after under- ng the high-altitude treatment, is shown in many of of. Weber's, as well as my own cases. M. Jaccoud, Saint Moritz, says the respirations are not only more quent but fuller, and remarks: "This circumstance ngs into use certain portions of the lung which I call e, because they ordinarily take but a small part in piration." [1] Dr. Jourdanet's opinions are evidently ressed with the desire to prove his theory — désoxy- ation de l'air — that the deficient oxygen inspired at at elevations is the cause of the immunity from phthi-

As I must differ with this noted author, in refer- e to the rationale of high altitude therapeutics, I may excused for quoting, and commenting at length upon views.

'We have stated that anæmia is the habitual condi- n of men who people great elevations, — anæmia by imperfection of the respiratory act. If it is natural admit, *à priori*, that this anomaly may have a neces- y influence upon the beginning, nature, and progress maladies in general, with how much more reason must acknowledge that the organ which presides over the piratory functions would feel the influence of it? The gs, in fact, find they have to deal with a dry, rarefied of diminished barometrical pressure. The three con- ions of dryness, rarefaction, and lightness of the at- sphere evidently render the endosmose of oxygen, tined to feed respiration, less easy. But if we are rect in saying that the most natural stimulant of any an is the element in which it acts, we may affirm, hout fear of contradiction, that the lungs are always

[1] *La Station de San Moritz*, p. 34.

stimulated in a less degree upon the heights than at the level of the sea." After clearly showing evidences of considerable immunity from phthisis on the Anahuac, and at other elevated stations, he continues: "Moved by the consoling spectacle of this happy influence of great elevations upon consumptives, I have sought a reason for it, with the view of turning this fact to a practical account. Several elements are grouped in my mind, in the resolution of this difficult problem. Upon one hand, I am governed by an incontestable fact, already generally proclaimed throughout this work, that the chronicity of inflammatory affections is incompatible with the climate of the heights. On the other hand, I consider the rarefaction, lightness, and dryness of the air. The rest which results from these conditions excludes the idea of any permanent excitation of the lungs. I consider that, under these circumstances, the lungs find a guaranty against pulmonary phthisis; while upon the coast, in a heavy and humid atmosphere which oxidizes everything with which it comes in contact, a general predisposition to a chronic inflammatory condition favors the progress of tuberculization."[1]

Let us, without objecting to the ultimate facts they are intended to explain, briefly dissect these anomalous theories, namely: the deficiency of oxygen and resultant anæmia; the rest and quiescent state of the lungs; and the difficult endosmose of oxygen.

This "respiratory diet," as Jourdanet calls it, — the theory which makes a deficient supply and lessened inspiration of oxygen the cause of the immunity of high altitudes, — takes no cognizance whatever of the adaptability of the respiratory function to changes in elevation. The bare mathematics by which we get this deficit for altitudes, which Dr. Vacher reckons is "a daily deficiency of 139 grams" of oxygen for an ordinary person

[1] *Le Mexique et l'Amérique Tropicale*, p. 295.

at Davos, throws out of consideration the existence of a pneumogastric nerve, with its reflex function to supply any lack of air, or oxygen, its vital constituent.

I make a distinction between the deficiency of oxygen and the accompanying stimulation of the respiratory function. The fact of this compensation is of so great importance as perhaps to more than supply any deficiency of oxygen. I refer to altitudes between four and eight thousand feet, which are those we are considering; or rather, to be more particular, elevations from four to six thousand feet, for latitudes at and north of the fortieth parallel. The extreme and injurious effect of elevation, even upon healthy persons, is not here intended to be gainsaid. Therefore, the possibility of misconceiving Dr. Jourdanet's views, based as they probably are on these extreme influences, is frankly admitted. And that these views were founded on extreme results is justly inferred from the following remarkable experiments,[1] in which Jourdanet has been personally interested, to substantiate his own conclusions. We are enabled by these important developments to study the possibilities of existence — in the case of birds — in confined atmospheres, variously rarefied, and so deprived of oxygen, the vital constituent. Through these experiments, the remarkable truth is revealed to us, that there is uniformly a certain portion of oxygen, equivalent to three and one half to four per cent. of the air at sea level, which is *irrespirable.*

The credit for the discovery of this important fact is due to M. Paul Bert, of Paris, whose zeal and many experiments in reference to this question won for him the highest prize given every two years by the French government, namely, 20,000 francs. He put birds (sparrows) into different sized jars, and exhausted the con-

[1] *La Pression Barométrique. Recherches de Physiologie Expérimentale.* Par Paul Bert; G. Mason, Editeur. Paris, 1878.

tained air to represent various degrees of pressure, and then noted the duration of their lives. Afterwards he analyzed the contained air to determine the amount of oxygen and carbonic acid remaining. The results were as follows: The birds died in times nearly proportionate to the amount of air in the jars, and its richness in oxygen. The proportion of oxygen the jars contained after the death of the birds, as compared with the quantity in the jars when the experiments commenced, gradually increased as the pressure was made less. This residual of oxygen, which Bert calls the "tension of oxygen," when computed for a pressure equivalent to sea level, was always equal to from three and a half to four per cent. This much was irrespirable, which amount in fact constituted a larger and larger proportion of the oxygen the jars contained when the experiments commenced, until the four per cent. at sea level was equivalent to nearly the full amount of oxygen existing in the jars, or to a rarefaction of the air approximately equal to over 34,000 feet above the sea. On the other hand, the carbonic acid in the residual air as steadily and proportionately decreased as the pressure in the jars was lessened; namely, from 14.8 at sea level to 8.1 at about the equivalent of 28,000 feet elevation, and 0.6 at about 34,000; the percentage of oxygen remaining, at the same pressures, being respectively 3, 11.5, and 19.6. Thus we see that while, proportionate with the lessened pressure, the air is less and less respirable in confined jars, there must always be left an amount of oxygen to equal three and a half to four per cent. at sea level.

We have here instances of death purely from a diminution of oxygen, the chemical constituents of the residual air making little difference, since not enough oxygen had been absorbed to favor the generation of an injurious amount of carbonic acid. But we must bear in mind the extreme rarefaction at which these deaths occurred, an

equivalent of probably over 34,000 feet above sea level. This is far beyond the possible exercise of any of the compensating conditions we must take into consideration.

It is also a noticeable feature of these elaborate experiments that the residual oxygen did not decidedly increase, nor the carbonic acid remaining in the jars lessen, nor the duration of the lives of the confined birds greatly vary, till a rarefaction equivalent to over 9,000 feet above sea level had been reached.

The application Paul Bert made of these results obtained in perfectly sealed jars, to the inhabitants of elevated sections generally, may reasonably be called in question. Aside from the probability that the carbonic acid, for pressures where it can be generated, has a poisonous influence on the confined bird, this forcing the air to irrespirable or poisonous states has no parallel in usual human experience.

That the generated carbonic acid began to exercise a somewhat poisonous influence at the small diminution of pressures in Bert's sealed jars, may reasonably be inferred from the fact that, when the pressures were increased above the normal standard, the carbonic acid remaining after the death of the birds increased to the equivalent of twenty-six per cent. at sea level, at which point the birds always died, evidently poisoned thereby. This death by carbonic acid predominated at pressures representing one and one half to three or four atmospheres. Then, as the pressure was increased, the toxic effect of condensed oxygen was evident by the lessening duration of the birds' lives in the jars. At length, when the confined air represented pressures of nine or ten atmospheres, the death of the birds, from concentrated oxygen, was instantaneous. Though it is indeed interesting to thus separately trace out these extreme causes of death in confined space, — namely, by the diminution of oxygen, by generated carbonic acid, and by condensed oxy-

gen, — yet they are all so unusual to man, and extravagant, when applied to the medium altitudes we are studying, that we must consider them mainly unsuited to the present controversy.

Aside from the compensating states of man for medium rarefactions, we should note how the atmosphere itself might make amends for its loss of oxygen. The more rapid movement of the air, radiation of heat, physical changes, etc., at great elevations, are questions which have to be taken into account. But an important rule may be evolved from these experiments, since the proportion of oxygen we can breathe, as compared with what exists at sea level, is constantly lessening, and so must be as constantly renewed, namely: *The greater the elevation above the sea the more does ventilation and out-door life become essential to healthful living.*[1] This rule is made positive and unavoidable by the facts presented as well as by the imperative necessity to breathe more air, according to its rarefaction, in order that the needed amount of oxygen may be obtained.

In the course of these remarks we have noticed the effect of elevation in cooling the atmosphere, and so tending to supply the deficiency of oxygen; also the effect of rarefaction of the air upon respiration, and the compensating states of man, for instance as shown by Seguin's estimate, that three or four times as much oxygen is absorbed in activity as in a state of rest. Now, if more frequent and deeper respirations do not compensate for the deficiency of oxygen, it is not proved that the endosmose of oxygen has any constant relation to the amount of oxygen inspired. On the contrary, Dr. Parkes says:[2] "In experiments on animals, as long as the percentage of oxygen did not sink below a certain point

[1] Note that this rule is directly opposed to the conditions, in confined jars, which are used to verify Dr. Jourdanet's conclusions.

[2] *Practical Hygiene*, p. 407.

(fourteen per cent.), as much was absorbed into the blood as when the oxgeyn was in a natural proportion." This does not take into account any augmented respiration due to elevation or any other cause. From these experiments the important inference can be fairly drawn that there is an *overplus* of oxygen in the air above what is used in ordinary respiration.[1]

It is much more probable, in view of the more perfect combustion (oxygenation) which takes place in consumptives who move to the highlands, that this deficiency of oxygen is more than compensated for in the altitudes we are considering. As to "anæmia by the imperfection of the respiratory act," which "is the habitual condition of men who people great elevations," it is well to avoid any misconception of the meaning of this term. The very general loss in weight, experienced by fleshy or nervous persons in high altitudes, does not seem to be due to any want in the quantity or the quality of the blood, but rather to a more complete and rapid combustion of the carbonaceous supply common to all in varying degrees. While the roundness of physique is in a measure lost and the wrinkled skin and early gray hairs indicate that the ageing process is perhaps going on more rapidly, yet the complexion is generally florid and the circulation different from that known as the anæmic condition.

Let us examine this interesting point further, especially noting the changes in the density of the respired air while it is in the lungs. I have already referred to the wonderful extent of respiratory surface in the lungs. This large area and the considerable change in atmospheric pressure are two striking factors of the changed respiration due to elevation. The mechanical effect of

[1] If it is a fact that there is an overplus of oxygen (not including the residual three or four per cent. which is shown above to be irrespirable), I have not before seen it stated.

this lessened atmospheric pressure is what chiefly interests us. With the atmosphere, say one fifth rarefied, the respirations are deeper and more frequent. Then the density of the air in the lungs during inspiration would seem to be lessened in proportion to the greater quantity of air which has to be breathed. This increased approach to a state of vacuum in the lungs tends to draw the blood quickly into the pulmonary vessels, which movement of the circulating fluid is aided by the accompanying increased action of the heart. But expiration follows, and it is during expiration that the respiratory muscles have the greater power, — greater because the muscles of expiration are in their normal condition for activity when the thorax is distended, and the thorax is more distended because it has to labor with more air.

I have already expressed the opinion that expiration, rather than inspiration, is shortened by the diminished pressure of elevation. This would still further show the increased advantage of the expiratory muscles. Then the density of the air within the lungs is suddenly made greater than the density of that outside the body. The blood-vessels are pressed upon and the previously augmented flow into the lungs is impelled towards the left side of the heart. It is possible that in very great changes of elevation, as in the rapid ascent of mountains above 12,000 feet, or rising to a great height in a balloon, the pulmonary vessels may not bear this alternate rarefaction and pressure, and hemorrhage may result. But we are speaking now of reasonably high altitudes, which must be considered as varying for different invalids.

The more rapid and perfect renewal of the capillary circulation in the lungs, is opposed to the stasis of blood which is an early stage of inflammation. Not only that, but chronic hypertrophied endothelium and the foci and products of inflammation in intercellular tissue are

crowded outwards from the air passages by this pressure, increased from within during expiration, and thus their absorption is accelerated. The expectoration, accumulations of mucus, epithelial débris, etc., may by the same increased movement of the respired air be better loosened and thrown off. The lungs, thus purified and cleansed of the results of inflammation and morbid principles of lingering tendency, have no place for adventitious products or the deposit of tubercle.

Is this accelerated activity of the pulmonary vessels and tissue a condition of anæmia, and is it here we find the "rest" which excludes the idea of any permanent excitation of the lungs? There is no rest for the lung, and in this fact lies its salvation. Rest is advantageous in some acute conditions, but it offers no special antagonism to progressive degeneration of lung tissue, even if, as is here erroneously assumed, "the lungs are always stimulated in a less degree upon the heights than at the level of the sea."

As to the "endosmose of oxygen" being less easy in high altitudes, how, may I ask, if it is so, can the lungs whose function is the endosmose of oxygen enjoy the rest claimed? Is it natural for an organ to be at rest the activity of which is obstructed? I can see no obstacle to the endosmose of oxygen due to lessened atmospheric pressure; on the contrary, almost every effect of the rarefaction of the air is to complete and perfect this process. According to Dunglison, "the rapidity with which endosmose is accomplished varies according to the nature of the septum or tissue, and of the penetrating body, and to the penetrability of the tissue." Now, in high altitudes, the improved capillary circulation, more particularly in the lungs, the quickened flow of blood on one side of the intercepting membrane, and the proportionately increased pressure and rapid renewal of the air on the other, all combine to favor the endosmose of oxygen.

It is not necessary, then, for us to burden our minds with doubtful problems in order to understand the healthful influence of the atmosphere of moderately high altitudes upon the organs of respiration. This more perfect oxygenation and capillary circulation of the blood assists a healthy renewal of tissue, and is constantly washing out of the system and preventing the focusing of impurities or disease germs, of which the consumptive body is full.[1]

The improved respiration and circulation make new demands for increased digestion and alimentation. Not only the lungs and heart, but the stomach, liver, and kidneys, all contribute a share of this increased labor towards sustaining a quicker but more perfect life. The loss of flesh in one, and the gain in another, — the latter, especially, for those new-comers for whom simply *to live* "is gain," — are but the preponderance of waste and repair over each other, which come to all with varying results.

[1] An exception should here be noted, that this purifying process may be too great a task for the feeble vital force remaining. Too extensive or far-advanced disease of the lungs, the system being saturated with its accumulating effects, may naturally prove too strong an enemy for this or any other purifying process; so that, in the heated contest which is inaugurated, the victim is quickly consumed. Such has been the fate of many who have suddenly risen to great elevations, for the sake of restoration to health, when already advanced in the last stage of consumption.

CHAPTER XI.

ALTITUDE OF APPROXIMATE IMMUNITY FROM CONSUMPTION.

THE THEORY OF AN EXACT LINE OF IMMUNITY. — NO GENERAL POSITIVE RULE. — THE ALTITUDE OF APPROXIMATE IMMUNITY IN EUROPE. — IN NORTH AMERICA. — IN SOUTH AMERICA. — IN MEXICO. — ALTITUDE OF IMMUNITY IN COLORADO. — CASES ABOVE SIX THOUSAND FEET. — BELOW THAT ALTITUDE. — EFFECT OF PROGRESSIVE CIVILIZATION.

THE study of the geographical distribution of consumption gives us an additional and remarkable evidence of the curative influence of high altitudes: to use the words of Shakespeare, "This fortress built by nature for herself against infection." If a certain locality or mode of life gives a large number of persons immunity from this disease, there is the strongest possible ground for the inference that the afflicted, who can and will adopt the same place of abode, or manner of living, may reasonably expect special chances of recovery. Some writers have contended that an exact line of freedom from consumption could be drawn, depending upon altitude and latitude. Among others, Küchenmeister made such close estimates as to give a rule for the altitude of immunity in any latitude; in Germany, the difference for different latitudes being 375 feet less for each degree from south to north.[1] At the equator, the line of immunity was placed at 9,000 feet, and in Switzerland at 3,000 feet, an estimate which is too low by one or two thousand feet, according to the valuable statistics of

[1] *Die hochgelegenen Plateaus als Sanatorien für Schwindsüchtige*, von Dr. Friedrich Küchenmeister.

Lombard, who was one of the first to notice the rarity of phthisis in the high-lying habitable districts of Switzerland.

But there are local conditions, variations in the climatic attributes we have thus far considered, which would be apt to invalidate any exact rule of this kind. For instance, the Coast Range of the Sierra Nevada Mountains, in California, which condenses much of the moisture from the constant Pacific winds, offers an entirely different climate from that of the elevated portions of the next range, and the latter, in turn, from the central range running through the continent.

It is better, perhaps, not to enunciate any positive law; because, if an opponent meet with any type of consumption originating above the stated elevation, we have attempted too much, and can go no further with him. It is not here asserted that a given altitude *always* insures freedom from consumption, nor that an approximate immunity may not exist at some low levels, as is claimed for certain regions far to the north, and for a steppe in Asia, said to be one hundred feet below sea level, inhabited by an extensive and vagrant population. We know little of these places, and, as with new gold-fields and far-off favored localities, to which "distance lends enchantment," we are suspicious of undesirabilities. However, as before shown, the cold in the one case and the augmented influence of the sunshine in the other, insures the dryness which is characteristic of the heights.

The argument presented is, that if twenty to thirty per cent. of all deaths occurring on the coast and borders of rivers are from consumption which originated there, — as on the fortieth parallel in the United States, — ten to twenty per cent. on higher ground, under 1,000 feet; five to ten per cent. from that height to 2,000 feet; two to five per cent. from that height to 4,000 feet; one to two per cent. from that to 6,000 feet; and seldom a case

above that point; then the proof is conclusive enough in favor of high altitudes as a resort for consumptives, even though a Signal Service observer on Pike's Peak should there suffer a lesion of the lung, which should eventuate in his death from consumption.

We speak, then, of an altitude of *approximate immunity*, which, like the good qualities of high altitudes previously discussed, is found higher up as we approach the equator. And in this fact lies the strongest proof, aside from the experience of a considerable number of invalids, of the soundness of the combined arguments presented in the foregoing analysis, *the most favorable conditions advancing hand in hand with the most favorable results, and culminating in the desired immunity.*

An additional evidence, in favor of an approximate immunity due to elevation, may be gained from the low rate of mortality from pneumonia, as well as from consumption, as shown by our census statistics, especially since we are coming so generally to consider phthisis as of inflammatory origin. It is that, while high altitude increases the unfavorable prognosis in *acute* pneumonia, the ratio of deaths from this affection, in the Rocky Mountain States and Territories, is considerably less than in lower regions, especially the Southern and Middle States, showing that there must have been few cases of pneumonia in the higher districts to have passed into chronic disease.

Drs. Weber, Lombard, Jourdanet, C. T. Williams, and Walshe, have given, in valuable works already quoted, abundant evidence from mortality records of the gradual decrease of deaths from consumption originating in high lands.[1] In general, the altitudes of approximate immu-

[1] These authors are amply corroborated by Küchenmeister, Brehmer, Archibald Smith, Füchs, Nühry, Vacher, Spengler, Hirsch, Guilbert, and others.

nity are a little above the elevations of favorable high altitude climates given in the first part of this work.

In Europe, Dr. Vacher tells us that, during a practice of six years in Mont Doré, he has seen but two cases of consumption among the native population; both of which were contracted at lower levels.

Dr. Spengler, a resident physician of Davos, testifies in favor of the immunity of that locality, and says he has not met with a single case of indigenous phthisis during a practice of fourteen years. Dr. Brügger states that consumption does not occur among those inhabitants of the Upper Engadine who have not left their country.[1] According to the facts collected by Hirsch, there is almost an absolute immunity in the mountainous regions of Thuringia, the Tyrol, and Abenharrz; and Lombard writes that at Erivan, a city high up among the Caucasian Mountains, the disease is very rare.

In America, Dr. Wight characterizes the inhabitants of the Cumberland table-lands as "a people without consumption," their mode of life probably having much to do with their immunity. In New Mexico, Arizona, and Utah, not a little evidence of an altitude of immunity is shown in communications I have had the pleasure of receiving from army surgeons who have served at elevated stations.[2] Surgeon John F. Hammond, United States Army, writing on the diseases of New Mexico, Rio Grande valley, says: "Phthisis pulmonalis I have never seen in the country except in two instances: once in an officer of the United States Army, and once in an American emigrant. It was developed in each before he left the United States, and each very gradually improved."

[1] *Climate of the Swiss Alps*, Hermann Weber, M. D.

[2] Among other army surgeons who have written in corroboration of marked immunity at their stations, are B. G. McPhail, Camp Apache, A. T.; W. J. Wilson, Fort Bayard, N. M.; Oscar A. Woodworth, Mesilla, N. M.; J. V. Lauderdale, formerly stationed at Tucson, Arizona, and C. B. White, Fort Independence, California.

Dr. Irwin reports for Fort Defiance (6,500 feet), northwestern New Mexico, "during a service of some seven years in New Mexico and Arizona, ranging over a region embraced between the 31st and 36th degrees of north latitude, — Fort Union, New Mexico, to Fort Buchanan, Arizona, — I never saw or heard of a case of tuberculous disease amongst the native inhabitants of those territories." Surgeon E. P. Vollum, from Camp Douglas, Utah, writes: "In an experience of three years and a half in Utah, I have not seen a case of consumption that originated in the territory, and the Mormon physicians declare that no persons born in Utah — excepting Indians — have had the disease to their knowledge."

Dr. Archibald Smith, who practiced medicine a long time in the Peruvian Andes, says that phthisis was unknown above 8,000 feet, "except as an exotic," which evidence, Dr. C. T. Williams well remarks, "is important, because we know that even up to 13,500 feet, large towns are found in that part of South America, such as La Paz, the capital of Bolivia, and therefore there probably exists some of the causes specially favorable to the development of phthisis."

Of the Anahuac in Mexico, as a region of almost complete exemption from this malady, we have ample evidence in the experience of Jourdanet, who places the line of immunity at 7,000 feet, and records that during two years' practice in Puebla, and eight in the city of Mexico, embracing a population of 270,000 inhabitants, he met with remarkably few cases of consumption. These occurred chiefly among the natives whom business interests induced to visit lower levels, and the indigent — a class rendered quite numerous in Mexico by natural indolence, acquired habits, and defects of social organization. He adds that if the inhabitants would take ordinary hygienic care of themselves the disease might be wholly banished. That this immunity from consumption is not one of priv-

ileged latitude is evidenced by the fact that at a few leagues distance, where the Cordilleras slope toward the sea, this disease increases in direct proportion to the descent.[1]

Dr. J. C. Davis, at present in Denver, who lived nineteen years in Zacatecas, Mexico, 8,160 feet above the sea, tells me he did not have an average of a case of consumption a year, in an extensive practice there, and those could be traced to pneumonia, or a similar cause, badly treated.

After having quite thoroughly canvassed the subject, among the physicians of Colorado, I place the altitude of approximate immunity in this State at 6,000 feet. I found but two or three cases originating above this altitude, none of them very well authenticated, — one was said to have been a case of catarrhal pneumonia of the right apex, which afterward improved, the other cases were among negroes, under circumstances which rendered them uncertain criteria. Physicians generally, who have practiced in the mountain districts for a considerable time, reported that they could furnish no cases of the kind from their experience in Colorado.

Between the elevations of 4,000 and 6,000 feet, however, I found some evidences of the disease. There have been about thirty instances in all, claimed to have occurred up to the present date, in the practice of the physicians interrogated, most of whom have resided in Colorado several years. By examining into these cases, we shall learn that it is owing, in a great measure, to the vagueness of the general term phthisis, that most of them come under this designation.

Boulder reports five cases: three of the patients have died and two are doing moderately well; all of these commenced with severe colds from exposure, resulting in pneumonia with three, which was said to have run into

[1] *Le Mexique et l'Amérique Tropicale.*

chronic disease. The length of time these patients were ill, or had lived in Colorado, was not stated. Golden reports an instance of general tuberculosis following miscarriage, rapid decline, and death in four months. Also a doubtful case of abscess of the lung, following pneumonia in a young man whose father died of phthisis, and which has resulted in an apparent recovery. A case is reported from Colorado Springs of a young man aged eighteen, three years a resident of Colorado and with very marked tendency to phthisis by inheritance. He had had a slight cough five months, when he received a severe injury to one lung, followed by hemorrhage and death in one month. Pueblo sends me two examples, "one a sequel to scarlatina, and one following extreme exposure, both badly treated and both fatal."

For the city of Denver and immediate vicinity, we have the records of all the deaths occurring since January, 1874 — four years and a half. These records require information from the physician as to the origin of the disease. We find fourteen cases recorded as originating in Colorado. They are of "phthisis," "phthisis scrofulosa," "acute phthisis supervening," as a sequel to other diseases, etc. I have interrogated most of the physicians, who reported these cases, and find two acknowledged mistakes, in that the disease existed before the parties came to Colorado; three rapid cases of cachexia Africana: two examples of rapid decline after childbirth; a child one month old, whose mother died of the same disease nine days later; a case of abscess in the base of the right lung, following pneumonia; acute phthisis following pneumonia and hip-joint disease: an instance of "whiskey consumption"; a fatal result in a very strong man after hemorrhage from severe lifting; and a case following scarlatina.

It is difficult to see that elevation offers any special antagonism to such cases; and as to accidental lesions

of the lung, causing hemorrhage, and also acute double pneumonia, the mechanical influence of rarefied air cannot for a time be considered otherwise than injurious: while phthisis following scarlet fever is not to be wondered at, in that the convalescence from special fevers is generally noticed to be tedious in the Rocky Mountain regions.[1]

A question of great importance, which would apparently weaken the argument of immunity is this: Will not the collection of a large number of people in single localities, cultivation of trees around dwellings, and the moistening of the soil by irrigation, — which is a necessity of civilization along the eastern base of the mountains, — furnish a field for the origination of consumption? The answer is plainly in the affirmative, that the exemption must, in a measure, be influenced by such artificially produced conditions. We have already shown that shade and impurity of the air are not natural to high altitudes. *Dryness* and *increased sunshine* should supplement them. But consumption is proved not to be a product of climate alone; so when the influence of constant in-door life, over-work of mind and body, disappointments of various kinds, inheritance, possible contagiousness, and methods, independent of climate, by which the disease may be ushered into existence, are taken into consideration, there is then such a latitude of argument furnished in favor of an approximate immunity, as to place *the fact* of that immunity beyond successful controversy.

[1] I have known an instance of catarrhal and another of chronic pneumonia, contracted in Denver, in negroes, who subsequently recovered, but who would undoubtedly have died from phthisis had they been sick in the East; also three cases of uncured pneumonia, now doing well, which could fairly be classified under consumption; and a case of supposed phthisis following confinement.

CHAPTER XII.

ASTHMA, ETC.

THE IDEAL CLIMATE CORROBORATED BY EXPERIENCE. — THE RAREFIED AIR CURE OF ASTHMA IN THE ROCKY MOUNTAINS AND PLAINS. — DEFINITIONS. — THEORIES. — EXPERIENCES. — EMPHYSEMA.

WE have now, through the foregoing analysis, formed an idea of the most favorable constituents of a curative climate for chronic lung diseases, and have strengthened our preferences by meteorological and hypsometrical data of an extended section of our own country which supplies those favorable attributes to a considerable extent, as well as by the consideration of the infrequency of the occurrence of chronic consumption in such high lying plateaus. The only remaining and the chief evidence in favor of our ideal climate, is the experience of various classes of invalids who would there seem to have special chances of renewed life. It is sufficient for our present purpose, having through facts presented, established confidence in the expectations entertained thus far, to rely mainly on the general results which experience furnishes.

As might be expected with the changed conditions of the atmosphere which we have been considering, the organs of respiration are those chiefly influenced. It was for these organs the *ideal* climate was sought, which may now justly be said to be *real* in the localities emphasized, since clinical results are favorable.

We can summarize this remedial efficacy of the inland sunny and rarefied atmosphere, in the treatment of lung diseases, by saying that it chiefly springs from a healthy respiratory *activity*, which is opposed to the theory of *rest*, the paramount idea in the treatment of

most other diseases. It may be regarded as a form of respiratory gymnastics, the gauge being the lessened atmospheric pressure, which is about twelve pounds to the square inch at 6,000 feet above the sea. This effect can be illustrated as we particularize the various pulmonary affections which are influenced thereby, beginning with that one which is most decidedly benefited.

ASTHMA.

The perusal of the foregoing pages must have convinced the reader of a purpose to make an aggressive warfare against disease. If corroborating facts are abundant, as they seem to be, and the writer has well grounded reasons for his convictions, it is better he should be frank in stating them if he would present a new means of relief to the sufferer. When we think of the thousands of asthmatics throughout the land who are struggling for existence, with only the uncertain and feeble help of the usual remedial measures, and in ignorance of the relief their brethren have found in this Rocky Mountain section, we are reminded of him of whom Samuel Johnson wrote: —

> "Hides from himself his state and shuns to know,
> That life protracted is protracted woe."

There is evidently a palpable neglect by authors of standard medical works, especially American authors, in their not mentioning the inland elevated air cure for asthma; or otherwise this presentation may serve as a new means of relief for this class of invalids. Dr. Walshe says, in his "Diseases of the Lungs," "Change of air often proves the very salvation of these patients. But the kind of change that shall prove beneficial in any individual case can only be learned by experience." The uncertainty as to the medical treatment is also noticeable. A more favorable experience is presented here in Colorado.

Of all the remedies which have been recommended in the treatment of this troublesome malady, I know of none which can compare with the light air cure of this inland region. I speak thus highly of this prescription for I believe that, almost without exception, uncomplicated cases of asthma may gain decided relief or a permanent cure, along the eastern base of the Rocky Mountains. As to complications, the relief of asthma often more than counterbalances the unfavorable effects of elevation in heart diseases, cavities in the lungs, and marked emphysema (explained further on).

The mistaking of emphysema for asthma and the advanced age of some who have had asthma many years, with perhaps the lung tissue seriously involved, will possibly explain the only slight benefit sometimes received. Generally speaking, the relief is marked as the base of the mountains is reached, and often much lower down. If all the results were written, hundreds of the present residents in Colorado could be cited who had had asthma months or years, and had exhausted all the other known means of relief in vain, but who have been nearly or quite free from asthmatic symptoms since becoming residents here.

In the winter of 1873–74, some asthmatics, philanthropically disposed towards all similarly afflicted throughout the States, assembled in convention for the purpose of putting on record the generally favorable results of the effect of Colorado climate upon asthma. One hundred and seventeen histories were collected. In most of these the relief had been considerable or complete. These persons came from some twenty-three different States, more especially Pennsylvania, Michigan, Missouri, New York, and Wisconsin, and were then chiefly residing in Denver. This number would now represent but a small fraction of similar cases resident in Colorado. Granting that some not relieved in Colorado — a portion of whom

may have returned East — were not reported, yet it is important to note [1] that over sixty per cent. pronounced themselves cured in Colorado; nearly thirty per cent. were considerably relieved; while the rest were either partially relieved on the plains, or had to go to the still higher mountain country to breathe freely. The fact that they had averaged over two years in Colorado at the time of the meeting, without much recurrence of asthma, is proof that the relief in these cases was more or less permanent. The fact, on the other hand, that they had been asthmatic about ten years on the average before coming to Colorado, is some evidence that they were genuine cases of asthma. This last consideration was also strengthened by the corroboration of physicians generally who had to do with these invalids.

I notice this collection contains a few cases of "hay asthma," or summer catarrh. This disease seems to be very often cured while the sufferer remains at some given elevation in Colorado, as evidenced by several instances personally known to me. Relief, however, is not so uniformly found as in the case of uncomplicated asthma.

Dr. George M. Beard, of New York, made quite an extensive investigation of this subject of hay fever; [2] and among the replies he received from correspondents were the following, summarized, which show a decided influence of elevated climates upon the disease: "Where did you find the quickest and surest relief?" Replies: "At sea, 8; at sea-side, 19; in mountainous regions, 35; some portions of White Mountains, 15; Rocky Mountains, 7; in bed, in cool, close, dark room, 8;" — or, in elevated sections, 57; in other ways, 35. Again: "Have you ever visited elevated regions without benefit?"

[1] *Colorado and Asthma*, the record of these one hundred and seventeen cases.

[2] *Hay Fever, or Summer Catarrh: its Nature and Treatment.* By George M. Beard, A. M., M. D. Harper Brothers: New York. 1876.

(Some of these elevated regions were not very much so.) Replies: "No, 83; yes, 17."

I will give a few instances of the relief of asthma, by way of illustration, mainly taken from the records of my own cases: —

1. Mr. B. C., farmer, from Massachusetts, sixty years old. Came to Colorado in October, 1877. No inheritance. Asthma had commenced twelve years before. At times the spells were very severe, more especially winters. Had slept only in a chair for three or four years. The dyspnœa was somewhat relieved the last half of the way coming to Colorado through Kansas, and he arrived in Denver feeling considerably improved. Next day, on examination, I found the results of his protracted disease in his remarkably rigid chest walls, and in the imperfect action of some peripheral portions of his lungs, — the bronchial tubes being clogged with secretions, or considerably dilated in places, while the sonorous and sibilant râles, on forced inspiration, made up the usual *music-box* appearance found in such cases. November 21, 1877, Mr. C. called to say he could "lie down and sleep like a lamb," which he had not been able to do for the previous five years. "Could hardly believe his own improvement." This gentleman is still in Colorado (summer of 1879), enjoying comfortable health, and almost complete freedom from asthma.

2. A lady from Vermont, of marked nervous temperament, perhaps from long suffering, twenty-four years old and an asthmatic since childhood: from the age of fourteen till she came to Colorado had tried almost every means of relief in vain. She had been free from asthma but three or four days in each month, the exacerbations of the paroxysms occurring monthly. After marriage, she was advised to bear children with hopes of relief; but, two months after becoming *enceinte*, the asthma had so greatly increased she "had to come to

Colorado" (1874). Since then she has been almost entirely free from asthma, the attacks being both infrequent and slight. This lady is the picture of health, and prefers to make her future home under the shadow of the Rocky Mountains to risking a return East.

3. Mr. F. W. H., age twenty (spring of 1878), tall, sanguine, no inheritance. Up to the time he came to Colorado had had asthma since he was eight years old, mostly winters and springs; spasmodic variety; in all, one fourth of the time asthmatic. During a visit to the Centennial Exhibition had pneumonia, followed by hepatization; came to Colorado then, and has improved in every way. Results of pneumonia are still apparent in left lung, by contraction of the same, especially at base; slight dullness; bronchial and hitching respiration; increased vocal fremitus, etc., at apex. But there is increased weight, sensation of health, and he has had no asthma whatever since he came to Colorado, a year and a half previous to this record.

4. Mr. W., from Missouri, previous to coming to Colorado in 1873, had had asthma twelve years, constantly increasing, so that he could not lie down at night for considerable periods. Had traveled in Europe and the United States but found no relief. Experienced immediate relief on arrival in Colorado; no trouble about sleeping afterward. Sent for his family and took up his residence in Denver.

5. Mr. E., from New York; had had asthma since 1837; severe at times; came to Colorado in 1864; Asthma ceased after leaving Omaha; gained rapidly in flesh and enjoyed excellent health afterward. Lived in Denver since; cannot go east of the Missouri river without recurrence of asthma.

6. Mr. F., formerly resident of Illinois; had had asthma over twenty years, both in Illinois, Maryland, Ohio, Missouri, and Pennsylvania. Has lived in Den-

ver sixteen years and never had an attack here, while he always has it when he goes East.

There are very few exceptions to this rule of the recurrence of the disease on the return to the lowlands.

7. Mr. F. J. B. Crane, of Denver, was the chairman of the asthmatic convention already mentioned, and has shown much interest in his fellow-sufferers. He was from Detroit, Mich. "Had asthma for more than thirty years, and badly for fifteen; for over ten years had been disturbed every night; traveled in most of the United States and abroad without benefit; arrived in Denver in March, 1871; after three weeks was surprised one morning to find he had slept all night;" this he did every night after that while he remained; went to Detroit, the disease returning after a short time, and that winter he suffered more than ever before; returned to Colorado in April, 1872, and the asthma left him after two weeks and did not trouble him again until the next year, when again going East for a short visit, he was attacked with his old complaint while crossing the Missouri River at Omaha.

The plains at the foot of the mountains are not high enough for some asthmatics, who may find relief by going to the Divide or some of the mountain towns. A permanent residence here is in most cases necessary, as in the majority of instances the disease returns with the descent to the level of its origination. For instance, a young lady not relieved of asthma at Denver, lost her difficulty of breathing while in the cars on her way to Idaho Springs, two thousand feet higher up, and there was a slight recurrence of her trouble on her return to the lower level again.

What is the explanation of this marked effect? Taking into consideration the fact mentioned by both Tyndall and Parkes, that in the air of elevated regions there is a greater freedom from atmospheric germs, which are be-

lieved by their presence to be a fruitful source of irritation or disease; also admitting as important auxiliaries the increased amount of atmospheric electricity and the dryness of the air, and I am of the following opinion: This decided effect is due mainly to the *mechanical influence* of lessened atmospheric pressure. In giving the *modus operandi*, it is pertinent to define ordinary asthma as *a paroxysmal contraction of the circular muscles of the smaller bronchial tubes.* It does not very much matter, so far as our explanation is concerned, whether it is a primary neurosis — as from irritation of the sympathetic nerve — or is caused by reflex action. If, however, it is a secondary neurosis — as following prolonged bronchitis or emphysema with changed calibre of bronchial tubes and character of mucous membrane — then there is evidence of complications which must, according to their severity, influence remedial measures.

The muscles used in expelling air from the lungs are in a condition of normal activity when the chest is distended, while the muscles producing inspiration seem to be more intimately associated than the others with the constricted fibres of the bronchial tubes. Inspiration, then, as compared with expiration, is especially difficult because of this constriction. Now lessen the density of the air breathed, and the lungs must labor with greater activity, in order to get the same amount of oxygen as before, sufficient to sustain life. The increased respiratory labor compressing the air, gives a proportionately greater pressure on the inside of the lungs than before, compared with that of the surrounding atmosphere. This augmented force within, pressing outwardly, distends the constricted circular muscles of the bronchial tubes to a point where they lose their abnormal contraction. Their contraction is simply no longer possible; as with a hand we can lift a ball which the fingers can grasp, but if the ball is increased in size, a point is reached when the fin-

gers lose their power, and it is dropped. In such a way I conceive the expansion of the smaller bronchial tubes is produced by the outward pressure of the air within them. A lady, an asthmatic from Pennsylvania, while climbing the mountains with some friends, was so distressed with dyspnœa, that, coming to a large rock, she declared she could never reach the top. In response to the urging of her friends she made the effort, expecting to await their return on the top of the rock. But after a short rest, the difficulty of breathing had gone, and she ran with ease to catch up with them. What was it which so suddenly opened the bronchial passages to the free admission of air, if not this mechanical effect of the rarefied atmosphere?

Curiously enough, Dr. Niemeyer accounted for the efficacy of the inhalation of compressed air for the relief of asthma in a very similar way. To use his own words: "The greater the pressure upon the gas which we respire, so much the more of it is taken into the blood; hence a moderate degree of obstruction to respiration may be compensated for by augmentation of pressure upon the gas respired."[1] However, let us take notice that in both instances there is a correspondingly greater pressure of the air while it is being respired than of that outside the body; also that the pressure may justly be attributed to diverse causes; in the one case, the necessity to breathe more air; in the other, augmented pressure purely artificially produced.

EMPHYSEMA OF THE LUNGS.

Emphysema differs from asthma in being *a dilatation of the bronchial tubes or of the air-cells beyond their power of contraction;* the act of expiration being particularly difficult and prolonged.

I hardly know what to say about emphysema, so few

[1] *Practical Medicine*, by Dr. Felix von Niemeyer, vol. ii., p. 89, 7th ed.

uncomplicated cases, in my experience, have come to Colorado. I closely watched one patient with emphysema and was surprised at his improvement; but like most of my cases, his lungs were otherwise defective, and he came from the miserable climate of Chicago. The emphysema may have been secondary to a bronchial pneumonia which the climate benefited. Uncomplicated emphysema will usually be aggravated by elevations of 6,000 feet and above. I think this affection may be inferred as a complication in some cases of supposed asthma not wholly relieved by the elevated inland climate.

In regard to complications I will cite two cases from my records.

Rev. P. P., age forty-three (January, 1877): from Massachusetts: had always been rather weakly and, excepting the time he was in the army, has led a sedentary life. Grandfather had asthma, and a daughter has a tendency to the same. Summer of 1865 was considerably prostrated; went to Colorado and California. Has coughed for two and a half years, and had "asthma" in cold weather and on walking rapidly, for fifteen months. Been in Colorado seven months; did not greatly notice elevation on arrival; ascended Pike's Peak; cough and asthmatic symptoms have increased; weight not influenced. Examination revealed barrel-shaped chest with rigid walls, dilatation of bronchi, with expiration twice as long as inspiration; while bronchial respiration, mucous and sonorous rales localized, were marked. The diagnosis of emphysema complicating chronic bronchitis, led to the advice, which was followed, that he return to a lower section of country.

Mr. T. C. V., age twenty-nine. Manufacturer, from Brooklyn, N. Y. Small stature; light weight, 114 pounds (135 in health); father had asthma, which was also inherited. Ten years before the summer of 1879 asthma came on slowly, spasmodic attacks following a hacking

cough. Went to Minnesota in 1870, and asthma left him, but came back again on his return to New York. Again in Minnesota, summer of 1872, had asthma constantly; occasional attacks afterward in Brooklyn, as well as what was termed "congestive" asthma, chills, bilious attacks, and indifferent improvement up to summer of 1876, when he came to Colorado, where he still had asthma and dyspepsia. Next winter after his return East he improved under the treatment of "emetics and small doses of mercury." Then he went to California where he became worse, as well as again in Minnesota during the summer and fall of 1877. Improved next winter at home, but having asthma badly in Minnesota in summer of 1878, came to Colorado September 1 of that year.

It is interesting to try to learn the reason of this want of success, both by the changes of climate, and by medical treatment, for he said he had consulted twenty-eight different physicians in all. An examination reveals rather positive evidence of the co-existence of three separate diseases, complicating each other. *Asthma* is evidenced by the character of his wheezy respirations, sonorous and sibilant rales, spasmodic attacks of dyspnœa, and remarkable muscular development over the base of the thorax in front; *emphysema*, too, is known by the prolonged expiration, the barrel-shaped chest, tympanitic resonance, and dilated bronchi, etc., in the middle and posterior portions of the lungs; while *fibrous phthisis* is fairly shown by the dullness of the peripheral portions, especially at apex and base of right lung, which was also contracted and its movement restricted, giving crackling râles on forced inspiration, the cubic inches of air respired — as recorded by the spirometer — reaching one half the normal numbers for his height. Nevertheless this gentleman is doing passably well (summer of 1879) in Colorado.

CHAPTER XIII.

THE RESULTS OF THE CLIMATIC TREATMENT OF CONSUMPTION IN COLORADO.

THREE HUNDRED AND FIFTY YEARS SPENT BY TWO HUNDRED AND TWO CONSUMPTIVES IN THE ROCKY MOUNTAIN REGION. — CHARACTER OF CASES. — ANALYSIS AS TO STAGES OF DISEASE. — RESULTS. — BOTH LUNGS AFFECTED. — SEX. — NATURE OF DISEASE, ANALYSIS, AND CONCLUSIONS. — PARTIAL RECOVERY NECESSITATES PERMANENT RESIDENCE. — PULSE, RESPIRATION, AND TEMPERATURE OF FAVORABLE AND UNFAVORABLE CASES. — ANALYSIS AS TO AGE. COMPARISONS AND CONCLUSIONS.

THE value of the experiences of consumptives who have sought health in these elevated western plains, may be fairly estimated through the honest presentation of them as they have occurred in an active practice in the heart of this section. This I will endeavor to do, feeling that I have recorded a large enough number of cases to warrant generalizations as to the various stages, types, and conditions of disease. I must, however, express my sense of incapacity to do the subject justice, especially as to fine distinctions in reference to types of consumption, such as I fear some of my professional brethren would require, even in this transitionary stage of medical opinion.

The claims for consideration which these records present, rest partly on the fact that they are confined to the time the patients actually resided in Colorado. In this connection it is to be noted that the results, after patients left the high altitudes, were generally unfavorable. If they again returned to the Rocky Mountain region in an advanced stage of disease as compared with that which they had during their previous visit, it has seemed

best to classify these as new patients. This is the case with some fifteen of my list.

The following results in Colorado, Wyoming, and New Mexico — mainly in the vicinity of Denver — are compiled from the 260 records I have preserved during the five years' practice in Denver, ending March, 1879. Very few records have been lost; and only those are excluded which come under the following divisions, namely: —

First. — Twenty-four not heard from after the first examination, whose records are therefore practically valueless.

Second. — Twelve whose disease was so doubtful, as hydropneumothorax, or complicated, as with heart disease or syphilis, that they could not be justly included; and, —

Third. — Twenty-two who were not in Colorado two months or more and therefore were unproductive of definite results. Quite a number of these, however, were sent back to lower levels, because the rarefied atmosphere was unsuited to them.

Then of the 202 recorded cases, twenty-two were lost sight of, after a time averaging over six months, seven being in the first, five in the second, and ten in the third stage, but who are probably now in Colorado, and whose records were complete enough to be included. As to the severity of these cases there is evidence that they were at least equal to the average.

The following is a comparison with my own cases of Dr. Pollock's subdivision of 1,200,[1] as to the stages of disease; both reduced to percentages.

	First Stage, Deposit.	Second Stage, Softening.	Third Stage, Cavity.
Dr. Pollock's	33	32½	34½
My own	37	21	42

[1] *Elements of Prognosis in Consumption*, by James Edward Pollock. London. Longmans, Green & Co. 1865.

There may be need of some explanation, why a relatively small proportion of my cases are in the second stage. I believe the influence of the lessened atmospheric pressure at Denver, producing, as it has a tendency to do, a greater expansion of the lungs, with *dry* air, shortens the period usually allotted to this stage, and *hastens the transition of the already softening portion of the lung, to a stage of excavation.*

In quite a large proportion of these cases, also, both lungs were affected, — 113 out of 202, as compared with 589 out of 1,200 of Dr. Pollock's list, and some of these cases were so far advanced as to warrant no hope whatever; for instance, in two, both lungs were in the third stage, and one or two were acute tuberculous cases.

The character of the cases is also somewhat indicated by the amount of *inheritance.* Reckoning those as having *marked inheritance*, whose mothers died of consumption, or whose father and one or more of the family died of the disease, or those, a majority of whose immediate relatives succumbed to this malady; again those, as having *slight inheritance*, who would seem to have some, but less than the above; and all the others as *no inheritance*, and we have the following record: —

Inheritance marked	54
Inheritance slight	61
Inheritance none	87
Total	202

The results from treatment of the cases so classified seems to confirm the conviction generally held, that inheritance has to be acknowledged a serious feature of this disease.

Some of these patients had inheritance marked to a surprising degree. For instance, I have in mind a little boy, whose mother brought him to Colorado when he was six years old, at which time I found partial consoli-

dation at one apex. He weighed four pounds at birth and seventeen pounds when four years old. His father died of phthisis, two months before this little fellow's birth. Seven out of nine brothers and sisters in his father's family died of the same disease. The mother had a chronic cough before and after the child's birth and some suspicious symptoms since. Five out of seven of her brothers and sisters have died from consumption. This child is now thriving, at the age of eleven years.

In my cases, the *males* more largely predominate over the *females* than in the lists of others, which in so far as it goes is a favorable circumstance, there being a hundred and forty-eight males to fifty-four females. This is due greatly to the facility with which men can leave home, take long journeys, and submit themselves to the life of "roughing it," common in the Rocky mountain regions during part of the year.

I will average these cases as to *stage of disease*, *nature of disease*, and *age* when they came to Colorado. I will note for each separate division the duration of disease before they came to Colorado, beginning with an evident cause, a pulmonary hemorrhage, pneumonia, etc., and also the duration in Colorado up to their departure from the State, times when they were lost sight of in Colorado, till death, or till March 1, 1879.

Thus we have *an analysis of 350 years spent by 202 consumptives in Colorado, with results.*

To the actual numbers I will add the percentages, which represent their proportion to the whole numbers in each separate division, as this method facilitates the comparison of results. Any necessary explanations will be added as we proceed.

STAGE OF DISEASE. (SEE TABLE XIII.)

Seventy-five (or 37 per cent.), of these cases were in the *first stage* (deposit) when they came to Colorado. These

averaged each one year eight months sick before coming, and one year seven months in Colorado. Results: much improved 64 (85 per cent.); slight improvement 10 (14 per cent.); and extension and advance 1 (1 per cent.).

Of these seventy-five, 2 (3 per cent.) have died in Colorado;[1] 3 (4 per cent.) after leaving; and 44 (59 per cent.) are known to be now living in Colorado.

Forty-two in the *second stage* (softening), being 21 per cent. of the whole, averaged one year five months each affected before coming to Colorado, and have resided here some over two years.

Results: 16 (38 per cent.) much improved; 12 (29 per cent.) slightly improved; 6 (14 per cent.) favorable resistance to the disease, though with perhaps slight local extension; and 8 (19 per cent.) extension and advance.

Three of these (7 per cent.) died in Colorado, 2 (5 per cent.) after leaving; and 26 (62 per cent.) are known to be now living in the State.

In 85 cases, 42 per cent. of the whole, excavation existed on their arrival. These *third-stage* cases averaged two years eight months sick before coming, and one year eight months residents of Colorado.

Results: 15 (18 per cent.) much improved; 22 (26 per cent.) slightly improved; 17 (20 per cent.) favorable resistance, etc.; and 31 (36 per cent.) extension and advance.

Sixteen of these (19 per cent.) died in Colorado; 14 (16 per cent.) after leaving; and 34 (40 per cent.) are known to be resident in the State.

Total: 202 patients averaged affected two years be-

[1] One of these two died from rupture of intestine. The other, a tuberculous young lady, having gained seven pounds while living on a ranche, riding horseback, etc., became suddenly worse through the questionable treatment of a physician in a neighboring town, who repeatedly applied a sixty grain solution of nitrate of silver for the relief of an aphonia, for which I had purposely refused to prescribe.

TABLE XIII.

| Stage of disease when they came to Colorado. | | |

fore coming to Colorado, and have been living in the State, an average each, of one year and nine months.

Forty of these, or 20 per cent., had died previous to March 1, 1879 — 21 in Colorado and 19 after removal — and 104 (51 per cent.) are known to be living in the State.

The results, while they were in Colorado, are as follows: 95 (47 per cent.) much improved; 44 (22 per cent.) slightly improved; 23 (11 per cent.) favorable resistance to the disease; and 40 (20 per cent.) extension and advance.

Conclusion. Judging from the record and the number who are yet living in Colorado improved or cured, and comparing these results with what I know of those of consumptives in the low-lying sections of our land, and I think the following may be reasonably inferred. ***The resort to high altitude climate by a consumptive gives a proportionately better result the earlier it is undertaken, even more so than is the case with less positive climates or means of cure.*** This conclusion is strengthened by the consideration that if the extreme climatic change had hastened a fatal termination in any of these cases (an idea generally held in reference to rapidly declining invalids, and the list contains some very unfavorable cases of this character), then such results must have been compensated for in the specially favorable improvement of others, who were — judging by these good results — well suited to the very decided change in climate. It is a noticeable fact, and in consonance with what we might expect, that there is a much greater contrast as to favorable results, between the first and second stage than between the second and third.

The converse of the above conclusion should keep the unfavorable *tuberculous* or *rapid* second stage cases at medium or low elevations. As might be expected, the results when both lungs were affected were much less favorable than the total results just given. These 113

cases, or 56 per cent. of the whole, were 38 (33 per cent.) much improved or cured, as against 47 per cent. when all the cases were included, and 85 per cent., when all but those in the first stage were excluded. The other subdivisions were 27 (24 per cent.) slightly improved; 17 (15 per cent.) favorable resistance; and 31 (28 per cent.) extension and advance.

The comparison of the results among males and females is found to be in favor of the former. The 148 males, — 73 per cent. of all the cases, were 74 (50 per cent.) much improved, against 23 (42 per cent.) of the females, who numbered 54, or 27 per cent. of the whole.

NATURE OF DISEASE. (SEE TABLE XIV.)

I cannot believe that post-mortem examinations of many cases would verify an exact classification, made at the commencement of disease, into the present various varieties, no matter who the diagnostician might be. This distrust is not a little strengthened by the thought Dr. Roswell Park expressed in his "Conspectus of the Different Forms of Phthisis," *i. e.*, "the greatest danger for consumptives is that they may become tuberculous." True it is, anyway, that the differentiation so nicely laid down in the books seems inapplicable to many of these cases because of the complications present at a given time; while in some one instance the character of disease at different periods has seemed to fairly represent separate varieties. It is to the point to quote from Dr. Bennet's work on the "Treatment of Pulmonary Consumption."[1] "All diseases are greatly modified in their symptoms and progress, as also in the results of the treatment to which they are subjected, by the form or type which they assume from their first development, and none more so than pulmonary consumption.

[1] *Pulmonary Consumption*, p. 119, by James Henry Bennet, M. D. Appleton & Co., New York, 1872.

TABLE XIV.

Nature of disease.	Number of cases.	Duration of disease before coming to Colorado.	Duration of disease after coming to Colorado.	Much improved.	Slightly improved.	Favorable resistance, though with slight local extension.	Extension and advance.	Favorable result.	Unfavorable result.	Number now resident in Colorado.	Number not resident in Colorado.	Died in Colorado.	Died after leaving Colorado.	Percentage. Much improved.	Slightly improved.	Favorable resistance.	Extension and advance.	Of each division to whole number of cases.
		Yrs. mos.	Yrs. mos.															
Inflammatory	77	88 3	127 8	55	13	4	5	72	5	42	18	3	4	71	17	5	7	28
Catarrhal	41	67 6	67	11	7	6	17	24	17	18	7	6	7	27	17	15	41	20
Chronic tuberculous	84	257 9	155 4	29	24	13	18	66	18	44	11	12	8	35	29	15	21	42
Total	202	413 6	350	95	44	23	40	162	40	104	36	21	19	47	22	12	19	100
Sent away to a lower level for a cause	12	- -	- -	-	2	-	10	2	10	-	-	-	7	-	17	-	83	6
Doing well, but became worse on going to a lower level	44	- -	- -	32	8	4	-	44	-	28	9	-	7	73	18	9	-	22
Went away and did well after leaving	11	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

On the above grounds, I prefer to study these types on a clinical basis rather than on an obscure histological one; that is, I prefer to refer the types of the disease to general pathology, which best explains them. At the bedside I have tried in vain to discriminate between catarrhal, pneumonic, scrofulous, fibroid phthisis, whereas the laws of general pathology have proved a safe guide."

How then, it may be asked, can confidence be placed in a given classification, extending over so long a period of time? Candidly we must admit the many sources of error, not the least of which, I grant, is the incompetency of the diagnostician in the present instance. There are general conclusions to be drawn, however, which, with considerable experience on the ground, may make us quite positive in our views.

In the following classification of results, it is possible that some *catarrhal* cases in the first stage come under the inflammatory group. The diagnosis of the catarrhal variety seems to be of less consequence in the first stage in Colorado, there being less contrast in results then, between it and the inflammatory class, than in the later stages of disease. The second or *softening* stage in the previous subdivision, contributes largely to the catarrhal in this. As it is mainly the prolonged third stage cases which add so large an aggregate of years of sickness in the other classification, they undoubtedly contribute largely to the *Chronic Tuberculous* in this. I use the word *tuberculous* in a somewhat general sense, as I cannot positively say these were all tuberculous.

I have chosen then, to mass these results under the following heads, however imperfect the classification may be: —

First: Inflammatory Phthisis, including uncured and chronic pneumonias, many cases of hemorrhagic phthisis, hepatization, and some probably of incipient fibrous phthisis.

Second: Catarrhal, adding scrofular cases and those complicated with cheesy pneumonia.

Third: Chronic Tuberculous Phthisis, including also the laryngeal variety, and many of the complicated fibrous, tolerated cavity, etc.

Analysis. — There were 77 in the *Inflammatory* group, or 38 per cent. of the whole. These averaged one year and two months ailing before coming to Colorado, and resided here one year and eight months. The results, as we would expect, were quite favorable, 55 (71 per cent.) much improved; 13 (17 per cent.) slightly improved; 4 (5 per cent.) favorable resistance to the disease; and 5 (7 per cent.) extension and advance.

Three died in Colorado, — one of them from rupture of intestine and one from intercurrent pneumonia, — and four after removal; 42 (55 per cent.) are known to be living in the State.

The 41 in the *Catarrhal* group were 20 per cent. of the whole. These averaged about a year and eight months affected before reaching Colorado, and have resided in the State about the same length of time. The results, as will be seen, are comparatively unfavorable. Only 11 (27 per cent.) were much improved; 7 (17 per cent.) slightly improved; 6 (15 per cent.) favorably resisted the disease; and 17 (41 per cent.) suffered extension and advance. Six of these (15 per cent.) died in, and 7 (17 per cent.) out of Colorado.

The *Chronic Tuberculous* group included 84, which was 42 per cent. of the whole. These averaged the long time of three years and one month affected before reaching Colorado (many of these had journeyed to other climates in search of health), and have resided in the State an average of one year and ten months up to the limit set, March 1, 1879.

The results of this class, as compared with the catarrhal, are very favorable, while the prolongation of

life indicated, for such a doomed class of invalids, is considerable. They are 29 (35 per cent.) much improved; 24 (29 per cent.) slightly improved; 13 (15 per cent.) favorable resistance; and 18 (21 per cent.) extension and advance.

Twelve of these (14 per cent.) died in Colorado, and 8 (10 per cent.) after leaving; and 44, or more than half of the 84, are known to be living in Colorado. Some of these, as well as many of the inflammatory group, are excellent examples of what may be reasonably hoped to be *permanent arrest.*

We therefore conclude, from the foregoing analyses, that *the inflammatory group and hemorrhagic cases are most favorably influenced by Colorado climate;* while the influence in the catarrhal and chronic tuberculous classifications is much more indifferent.

There is an exception in favor of the fibrous variety, which is quite favorably influenced even in the third stage, when only a small amount of lung tissue is affected.

But the catarrhal and tuberculous cases, especially with suspicious laryngeal complications, should not resort to great elevations while much lung tissue is actively involved in the disease.

It is further of interest to note that 12 (6 per cent.) of these cases were sent to a lower level because the climate of the higher districts became injurious, or was unsuited to them. Also, that while 11 went away and did well after leaving, there were 44 who became worse on going to a lower region,— mainly to their eastern homes,— and in consequence 28 (64 per cent.) returned to Colorado.

The second experience in Colorado of these mentally uncertain cases is usually not as gratifying as the first.

While in Colorado, these 44 favorable cases who went East, were, 32 of them (73 per cent.), much improved; 8 (18 per cent.) slightly improved; and 4 (9 per cent.)

favorably resisted the disease. The conclusion is, that *a somewhat prolonged residence is necessary in the climate, which gives a certain consumptive the greatest benefit.* This last conclusion serves to determine the length of time invalids should remain in the Rocky Mountain resorts, and is therefore of no little importance. The facts noted are that the 44 patients, more than half of those who went East, became worse thereby, and of these, 7 (17 per cent.) died there, though all were doing well before their departure. It is to be noted also (see Table XVI.) that, while 26 of the whole 202 patients had hemorrhages after coming to Colorado, 9 of the hemorrhagic cases had hemorrhage after leaving the high altitudes, which was probably a good proportion of this class of patients who returned to low levels.

Professor Weber's cases furnish similar evidence; of thirteen cases arrested in high altitudes, two were twice relieved, the disease twice returning on going down to sea level. In six other cases phthisis was rekindled after a descent to sea level; and two patients, who were residents of high altitudes, moved to the lowlands and became consumptive, but were apparently cured on returning to the highlands, and were again taken sick when they returned to sea level.[1]

Jourdanet, among many striking illustrations of a failing or falling off of consumptives after leaving the heights, mentions the case of a young lady who three times went down to a lower level with a renewal of active phthisis, and three times in turn was decidedly relieved by a return to Puebla. Dr. C. T. Williams mentions almost as remarkable an instance of this loss of benefit by return to low levels. Several of my cases show unfavorable results on going from Colorado to California. One patient, in the third stage of the disease, died two months after leaving the high altitude; and

[1] *Climate of the Swiss Alps.*

one in the second stage, in the vicinity of San Diego, lost ten pounds, had five hemorrhages, advanced to the third stage, succeeded in getting back to Colorado and improved for two years (in the sheep business on the Divide), when he returned to his old home in the East and died within six weeks thereafter. A third patient, in the first stage, was one of six young men, four of whom, I believe, were consumptive, who went to Southern California, under the restless impulse which often controls such persons. This young man, and two others of his party, were made perceptibly worse by their sojourn in California, and returned quickly to Colorado, considerably disgusted by their experience in the humid air of the Pacific slope. All of these patients were doing well enough in Colorado, and most of them assumed the responsibility of going to lower levels, contrary to advice.

As Jourdanet expresses it: "I preserve among my notes a great number of examples of the relief of the malady, and of the obstinacy of the invalids in returning prematurely to the climate which kills them." [1] And in reference to those who have returned to a lower altitude, he adds: "I often ask myself if actual residence would not have finally vanquished the malady which a few months' stay had relieved." By inference, I think, an argument might be drawn from the analogous experience of those gymnasts and athletes who abandon their accustomed exercise and, by so doing, render their lungs liable to disease from *lack of use*. For we are all the time speaking of healthful respiratory *activity*, as opposed to the *rest*, which is so desirable in the treatment of most diseases. Such is the experience which leads to the conclusion that *a partial recovery necessitates a permanent residence*. This statement carries with it the idea, consonant with experience, that complete recovery does not necessitate permanent residence, so that the

[1] *Le Mexique et l'Amérique Tropicale*, p. 304.

time invalids should consider it imperative to remain in high altitudes, is less for incipient or first stage cases, in which complete recovery may be expected to occur.

It is a useful and interesting inquiry to determine the general differences in pulse, respirations, and temperature, on arrival in Colorado, between those who did well, and those who retrograded. I have averaged such of my records as give complete data on these points, with the following results: —

P	Average Pulse Sitting.	Respirations per Minute.	Temperature Fahr.
Favorable cases . . .	91	20	99.6°
Unfavorable cases [1] .	106	27	101°

The average difference in the circumference of the chest between full inspiration and complete expiration was for the favorable cases $2\frac{1}{4}$ inches, with an average gain noted afterwards of $\frac{1}{8}$ of an inch. In the unfavorable cases the corresponding difference was $1\frac{9}{10}$ inches, with an average loss noted afterwards of $\frac{1}{8}$ of an inch. Of course these results may be greatly influenced by the times and the peculiar conditions when these records were taken, and so furnish no infallible guide; but the average differences of 15 pulsations, 7 respirations, and $1\frac{4}{10}$ degrees in temperature, are at least suggestive; while the fact of the increase of the capacity of the chest in those who did well, is something worthy of note, as corroborating the theory before advanced of the effect of the rarefied atmosphere.

CLASSIFICATION AS TO AGE. (SEE TABLE XV.)

Dr. Pollock concludes, in treating of age as a modifier of phthisis, "the more advanced the age, the more

[1] If these averages were to be the criterion as to the advisability of not sending a patient to high altitudes, I should put them a little higher;

TABLE XV.

Ages when they came to Colorado.	Number of cases.	Duration of disease before coming to Colorado.		Duration of disease after coming to Colorado.		Much improved.	Slightly improved.	Favorable resistance, though with slight local extension.	Extension and advance.	Favorable result.	Unfavorable result.	Number now resident in Colorado.	Number not resident in Colorado.	Died in Colorado.	Died after leaving Colorado.	Percentage. Much improved.	Slightly improved.	Favorable resistance.	Extension and advance.	Of total number of cases by divisions of ages.
		Yrs.	mos.	Yrs.	mos.															
Under twenty	13	11	11	21	4	8	1	1	3	10	3	8	2	-	3	61	8	8	23	7
From twenty to thirty	95	165	11	159	7	50	24	6	15	80	15	48	18	8	7	53	25	6	16	47
From thirty to forty	71	172	7	122	1	30	12	11	18	53	18	24	12	10	8	42	17	16	25	35
Forty and over	23	63	1	37		7	7	5	4	19	4	14	4	3	1	30	30	22	18	11
Total	202	413	6	350		95	44	23	40	102	40	104	36	21	19	47	22	12	19	100

likely is it that the form of the disease will be the latent in development, and the chronic in form."[1]

If one class of patients were under consideration — for instance, inflammatory cases — I should think, on theoretical grounds, the results of resort to high altitudes in the case of the young, as compared with those somewhat advanced in life, would be proportionately more favorable than obtains at sea level; *i. e.*, the greater improvement due to elevation would be rather on the side of those under than those over thirty-five. This is because acclimatization in elevated climates is more difficult after the chest walls become rigid with age and the nervous system less amenable to decided change. Let us see if this expectation is verified in this analysis as to age. Thirteen (7 per cent.) of these cases were under 20 years of age when they came to Colorado, and they averaged 11 months affected before arrival, and had resided 2 years 5 months in Colorado. Notwithstanding, as might be expected among young subjects, this list included two rather acute and unfavorable cases, yet the record gives the largest percentage, 61 (or eight patients), who were much improved or cured. But the better comparison for our purpose is that between the next two subdivisions, — 20 to 30 and 30 to 40 years. In the former, 95 patients (47 per cent. of the whole) averaged 1 year 9 months sick before coming to Colorado, had resided about the same time in the State, and 78 per cent. were much and slightly improved. In the latter group 71 cases (35 per cent. of the whole), averaged 2 years 5 months before coming and 1 year 9 months afterward, and were 69 per cent. much and slightly improved. It is further to be noted that the

say, as we find them in Colorado, pulse sitting, 110, respiration, 30, and temperature, 102°.

[1] *The Elements of Prognosis in Consumption*, by J. E. Pollock, M. D Longmans, Green & Co., London, 1856.

first of these two groups gave better results, while the group of those more advanced in years, gave worse results than the total number of cases. Also that those over 40 years of age, 23 in number (11 per cent. of the whole) — averaging 2 years 9 months sick before coming, and residing 1 year 7 months in Colorado — gave the poorest general results of all the ages. I assume that to climatic influence is due some of this disparity in results, which difference would be still more marked were the acute cases in the earlier periods of life eliminated from the list. Generally speaking, I think the resort to high altitudes by pulmonary invalids — excepting in the case of asthmatics — is not advisable after 55, and that any special benefit from the elevation lessens, in proportion to the age, after 40 or thereabouts.

It would be instructive to compare these results with those in other climates; but I have none at hand so recorded as to furnish very definite conclusions. However, allowing for the absence of similar data in the records of others, these tables may be considered as showing favorable results, especially for cases in the early stage of phthisis. It is difficult to compare them with Dr. C. T. Williams's records of English and continental resorts, because, in his analyses, those patients who died during the time of observation do not appear to have been included in the estimate. We are only told that "since the climatic treatment" 45 of the 243 patients (who spent 386 winters in English stations) have died.[1] It would seem to be an important inquiry whether any died during the climatic treatment.

The experience of Prof. Austin Flint, Sr.,[2] furnishes evidence of the favorableness of these results; for, accepting his collection of cases of arrested phthisis as the largest, or one of the largest, that can be made from the

[1] Lecture II. *Lettsomian Lectures.*

[2] *Phthisis*, by Austin Flint, M. D., p. 239.

experience of any one man in America, the results of the few cases I have presented must be admitted as an argument in favor of high altitude, in that the ratio of improvement is greater, although covering a shorter period of observation. He draws conclusions from his analyses of six hundred and seventy cases of consumption, being all he has recorded, but not all of those in which he has been consulted. For though he has not kept records of cases for the past eight or ten years, he says: "I should not have omitted to make records of cases of arrested phthisis coming under my observation." With this explanation, he continues: "Seventy-five cases must be nearly all in which I have known an arrest of phthisis to take place, either with or without complete recovery, during a practice of thirty-eight years." Now, though there is no analysis of these six hundred and seventy cases, in reference to altitude, several are mentioned, especially among these instances of arrested phthisis, which may be said to have received the special benefit of elevation. Among his patients were several who resorted to the Adirondacks with benefit; seventeen who went to Minnesota, and were, with four exceptions, cured or benefited while there; one who went to the Peruvian Andes and was cured; and one who passed eleven weeks in New Mexico, with decided improvement *while he remained.* Since, on the one hand, there is no evidence produced against high altitudes, and, on the other, so few of his patients resorted to elevated regions for relief, we are compelled to present the latter fact as the only excuse for Dr. Flint's giving elevation almost no consideration and for his arriving at the conclusion "that the benefit derived from the change of climate is due, not so much to a climatic influence *per se*, as to the circumstances incidental to the change." I shall be the last to take issue with this renowned author, or any one else, as to the importance of out-door life and change of

occupation; all the most useful means we can combine will not be more than enough to make the consumptive multitude reasonably healthy. Sometimes, by unfavorable cases, the physician is impelled to agree with Pope that, —

> "As man, perhaps, the moment of his breath,
> Receives the lurking principle of death;
> The young disease, that must subdue at length,
> Grows with his growth and strengthens with his strength."

The distinguished Dr. Pollock thus concludes his work, before referred to, in a synopsis of the results of change of climate (referring more particularly to resorts in Southern Europe, and emphasizing the results in cool, dry climates): "We cannot believe that a disease (consumption) of lowered nutrition, with consequent exhaustion of vital powers, is best treated in all instances by a residence in climates of the enervating and relaxing character; while on the other hand we have abundant evidence that all which is tonic and invigorating in external influences is productive of corresponding good in the vital system, provided that individual constitutions and requirements are carefully studied." Certainly there is strong evidence in favor of this conclusion, in the large number of reconstructed phthisical invalids who may now be found among the inhabitants at the base of the Rocky Mountains, enjoying life better than would have been possible in the usual health resorts near the sea, which many of them had previously tried.

CHAPTER XIV.

PULMONARY HEMORRHAGE.

HEMORRHAGIC CASES. — ARE THEY SUITED TO THE HIGH ALTITUDE TREATMENT? — TABLE OF RESULTS, WITH ANALYSIS AND CONCLUSIONS. — ILLUSTRATIONS.

THE question of the high altitude treatment of pulmonary hemorrhage is of great importance from the fact that many think it unfavorable, and so have advised against sending consumptives — especially hemorrhagic cases — to the foot-hill country of the Rocky Mountains.

It is evident that the authors of this too cautious advice were not cognizant of all the facts bearing upon this question. Certainly the reason stated — the probable recurrence of hæmoptisis, or pneumorrhagia, in Colorado — is not borne out by a careful study of the experiences of consumptives here. What effect, then, has elevation, and are hemorrhagic cases generally favorably influenced thereby? Is pulmonary hemorrhage more likely to recur in elevated climates, and, if so, in what class of cases? As I have thought for some time [1] that the pulmonary hemorrhages, seemingly caused by elevation, which have occurred in Colorado, have been from cavities in the lungs or in third-stage cases, I have sought to learn, by analysis of the foregoing cases, the truth in regard to this, as well as to the other points noted.

Out of the 202 cases, the 90 who have had hæmoptysis or hemorrhage at any time I have arranged with reference to the existence or absence of excavation, the times when hemorrhage occurred, etc. This brings us to the results as classed in the accompanying Table XVI.

[1] *Report to International Medical Congress.* 1876.

TABLE XVI.

Number having Hemorrhage or Hæmoptysis at any Time.	Number of cases.	Much improved.	Slightly improved.	Favorable resistance, though with slight local extension.	Extension and advance.	Favorable result.	Unfavorable result.	Number now resident in Colorado.	Number not resident in Colorado.	Died in Colorado.	Died after leaving Colorado.	Percentage. Much improved.	Slightly improved.	Favorable resistance.	Extension and advance.	Of total number of cases (202) by subdivisions.
Hemorrhage before coming to Colorado	64	34	7	9	14	50	14	33	8	8	4	53	11	14	22	32
Probable number of these, with cavity	28	7	2	6	13	15	13	12	4	7	3	25	7	22	46	14
Hemorrhage before and after coming to Colorado	18	6	6	1	5	13	5	7	4	1	4	33	33	6	28	9
Of these, cavity existed in	14	2	6	1	5	9	5	5	3	1	4	14	43	7	36	7
Hemorrhage after and not before coming to Colorado	8	2	1	3	2	6	2	5	–	1	–	25	12	38	25	4
Of these, cavity existed in	6	–	1	3	2	4	2	4	–	1	–	–	17	50	33	3
Total	90	42	14	13	21	69	21	45	19	10	8	47	16	14	23	45
Hemorrhage after leaving high altitude	9	3	2	3	1	8[1]	1	–	–	1	1	33	23	33	11	4½

[1] While they were in Colorado.

There were 64 (70 per cent.) of the hemorrhagic cases who had hemorrhage only before coming to Colorado; while 8 (9 per cent.) had hemorrhages after coming, and not before; and the period of sickness before coming, for all of these patients, was only $\frac{2}{13}$ longer, on the average, than the time they had resided in Colorado. As the times before and after coming were so nearly equal, would this disparity exist if the element of elevation had tended to cause bleeding from the lungs?

Now the 64 cases, who had hemorrhage before coming to the Rocky Mountains, were 34 (53 per cent.) much improved; 7 (11 per cent.) slightly improved; 9 (14 per cent.) favorably resisted the disease; and 14 (22 per cent.) suffered extension and advance. These 64 cases included the subdivision following in the table: namely, those having excavation. It will be seen by comparison that these were more unfavorably influenced than the third-stage cases in Table XIII., than the chronic tuberculous list in Table XIV., and almost as badly affected as the unfavorable catarrhal group in the same table. Nevertheless the results of the whole group of cases, having hemorrhage previous to coming to these heights, are more favorable than the average of the whole 202 cases. Therefore, *hemorrhagic cases are to be preferred, for the high altitude treatment, next to the inflammatory group.*

Twenty-eight of these early hemorrhagic cases (44 per cent. of the 64 in this table) probably had had softening before coming to Colorado, and in this group we see the most unfavorable results of any in the tables, nearly one half retrograding.

It follows then — that, *hemorrhagic cases with excavation are less suited to the high altitude treatment than third-stage cases, generally.* (See Table XIII.)

There were 18 (20 per cent. of the hemorrhagic cases)

who had hemorrhage both before and after coming, and 14 of these had passed the period of some softening. This allots to the third-stage class 44 per cent. of those who bled *only before* coming to Colorado, as against 78 per cent. of those who had hemorrhages *afterwards as well as before.*[1] A similar conclusion can be drawn from the next subdivision (those who bled only afterward), *i. e., hemorrhages without excavation are rare in high altitudes, while preëxisting softening seems to be, in a measure, causative of them.*

If we compare these percentages of results with those given in the preceding tables, we note that those who had hemorrhages after coming to Colorado — probably because of the advanced stage they mostly belonged to — gave results only slightly inferior to the chronic tuberculous group, and some better than all the third-stage cases combined. This happens, notwithstanding this last list included some who disobeyed orders and brought on hemorrhages by ascending mountains, the bases of which were plenty high enough for them; hemorrhages from causes decidedly not climatic; a case of probable metastasis of tuberculosis to the brain (not a strange occurrence considering the improved conditions for the respiratory organs); a case of valvular heart disease, with complete hepatization of the right lung, — at least a most unfavorable condition for altitudinarian treatment; and advanced third-stage cases.

All the hemorrhagic cases (90), notwithstanding excavations and other unfavorable complications, did nearly as well as the average of all the 202 cases; which circumstance would seem, by inference, to make it evident that *the hemorrhagic first-stage cases constitute a most favorable class of patients for high altitude treatment.*

[1] Incidentally we see that nine had hemorrhage *after* leaving Colorado, who had done only moderately well here. Surely other reasons than those of atmospheric pressure must explain some of these results.

As substantiating this last conclusion, I quote from Dr. Hermann Weber.[1] "In cases where there is a tendency to hæmoptysis, climate is of great importance, and I am in the habit of recommending prolonged residence in Alpine climates. I know that it is the general belief that elevated regions and rarefied air cause a disposition to hemorrhage; but this idea is based partly on theoretical reasoning, partly on the misinterpreted descriptions of the great ascents of Humboldt, Boussingault, and others who were, under circumstances totally different from those of an invalid, residing in a moderately high elevation. On the coast of Peru, where hæmoptysis is one of the most frequent affections, and the usual forerunner of consumption, the removal of the patient to the Andine valleys, especially the valley of the Janja, elevated between 10,000 and 11,000 feet above the level of the sea, is, according to the testimony of Archibald Smith, regarded as an almost certain cure. Among all the patients whom I have advised to stay at high elevations (in various parts of Switzerland, especially at St. Moritz, Pontresina, and Samaden in the Engadine, and at Davos am Plazt, as also on the Cordilleras of South America), there is to my knowledge only one who had an attack of hæmoptysis while on high ground, although there are amongst them ten who had previously suffered from severe, and mostly from repeated attacks of hæmoptysis.

I recommend Alpine climates, however, not only as a prophylactic measure against hæmoptysis, but also as a means to promote the cure of the effects of the inflammatory processes resulting from pulmonary hemorrhage."

My friend, Dr. Jacob Reed, Jr., of Colorado Springs, analyzed his cases with reference to this same question. In his report to the State Medical Society he presented a

[1] A pamphlet on *Hæmoptysis as a Cure of Inflammatory Processes and Phthisis, with Remarks on Treatment*, by Dr. Hermann Weber.

synopsis of 70 cases of consumption occurring in his practice during the previous three years.[1] Of these cases thirty-four arrived in Colorado before any softening whatever had taken place, in 15 only of whom hemorrhages had occurred, and in only one of these 15 did the previous hemorrhage recur in Colorado. Two of these 70 cases being unclassified, there were 34 in which some degree of softening had taken place before the patient's arrival in Colorado. But one half these 34 had had hemorrhage, in only 7 of whom were there bleedings both before and after their arrival. The doctor himself does not think the hemorrhages in these 7 cases — where they recurred in Colorado — can be attributed to the more elevated home. However, we see by a further study of these generally unfavorable cases, as well as those generally favorable in which pneumorrhagia did not recur in the Rocky Mountain country, that in all particulars there is a remarkable correspondence between the results of Dr. Reed's and my own experience in regard to pneumorrhagia in high altitudes.

The difference in results between the first and third stage hemorrhagic cases is not inexplicable. If we conceive the cause of hemorrhage in the first stage to be due to such a condition as a stasis of the blood, local apoplexy, congestion, or something of that nature, then our previously mentioned theory of the increased pressure outward of the air within the lungs, and improved or quickened circulation of the blood in lung tissues, would tend to preclude the existence of such an exciting cause of pneumorrhagia. On the other hand the necessity to breathe more air on the heights, inducing a proportionately greater stretching of lung tissue, would explain the liability to purely accidental hemorrhage from a softened portion of the lung.

[1] "Altitude in Reference to Pneumorrhagia." *Transactions Colorado State Medical Society*, 1878.

Therefore, *the advantages of high altitudes are preëminently for hemorrhagic cases in the first stage, while hemorrhagic cases with excavations, especially if the bleeding has been recent and softening is in progress, should be interdicted from going to great elevations.*

The favorable side of this subject is worthy the two following illustrations. In June, 1873, the son of a distinguished physician in Chicago came to Denver, having positive symptoms of extended disease in the right lung which had followed, and afterward been associated with, hemorrhage. This condition was wholly acquired, for there was no hereditary tendency to consumption in his case, and two years before, when his first hemorrhage occurred after "raising from the shoulder" a one hundred pound dumb-bell, his physique was excellent, his chest measurement being forty-two inches, and his weight one hundred and sixty-five pounds. Then, by the repetition of this hemorrhage, either from exposure or over-exertion, a condition of the lungs was induced, which by the spring of 1873 had resulted in positive disease. On this account he was sent by his father south to the Gulf of Mexico, preparatory to his coming to Colorado. The local affection in the lungs was carefully and almost unmistakably decided on (chiefly inflammatory), and the precaution taken, because of a recent hemorrhage, to be two weeks in approaching the base of the Rocky Mountains. Though the effect of the rise in elevation was not unpleasant, there was a "desire for more air," until after two or three weeks, when, as he expressed it, his lungs were "cleared up." Three years after his arrival in Denver, a careful physical examination of the chest revealed no positive signs of trouble, and this favorable result was corroborated by his vigor of mind and body. He had spent half of that time living on a ranch, driving, riding horse-back, and hunting, and the other half in town as a medical student. The later experience

of this gentleman is also very instructive, as it brings to view the liability to recurrence when such patients return to remain in the locality where their trouble commenced. Probably due to the continued application incident to graduation and establishing himself in practice in Chicago, hemorrhage and pulmonary trouble recurred, necessitating again a climatic change.

Another experience was that of a gentleman who now lives in Colorado Springs. He is thirty-two years of age, and was a woolen manufacturer in Burlington, Wis. There was no family tendency to lung disease, and he was large framed, over six feet tall, and in health weighed 175 pounds. In youth he bled easily from the nose, and three years before coming to Colorado he raised a little blood. During his last year in Wisconsin he had several attacks of hemorrhage, usually after straining, as in lifting. In February, 1874, he was very much prostrated by repeated hemorrhages, so that his life was despaired of by most of his friends. By advice of physicians, and after correspondence with me, he came to Colorado, and in this way. His camping "out-fit" (horses, wagon, etc.) was shipped to Kansas City, whence, though very weak, he started westward about June 1, accompanied by his father, wife, two children, and a man-servant. His improvement dated from the beginning of this out-door life. He was five weeks coming up the Arkansas River valley to Pueblo, thence three weeks to Denver. He continued the camping-out life for a while, and then settled in the real estate business at Colorado Springs. He has had almost uninterrupted improvement in health since, which was confirmed, the next year, by a physical examination showing a great improvement in the signs of weakness noted in the apices of both lungs, the left one particularly, at the beginning of his illness. A year ago he weighed 192 pounds. He is enthusiastic in his estimation of the means of relief

employed, and boasts that he has "passed muster" for an insurance on his life since he came to Colorado.

While we have known of invalids bleeding at Omaha and on the way to Colorado, and after their arrival being free from it, yet the precaution is a good one, to avoid a sudden and decided rise in elevation after a recent pulmonary hemorrhage, especially if there is a local injury or cavity in the lungs. A sojourn of a week at some midway station is advisable for some, as at Wallace on the Kansas Pacific, at Larned or Lakin, on the Atchison, Topeka, and Santa Fe, or at North Platte or Sidney, on the Union Pacific Railroad; or, better still, if in summer, a drive across the plains in a wagon with camping out on the way.

CHAPTER XV.

COMPLICATIONS AND CONCLUSIONS.

BRONCHITIS. — ILLUSTRATIONS. — PLEURISY. — NERVOUS AND RHEUMATIC COMPLICATIONS. — GENERAL CONCLUSIONS.

OF all the complications or symptoms of consumption there are hardly any more prominent, to the invalid at least, than chronic cough. Often the persistence and exhausting influence of this symptom fixes it in the sufferer's mind as the disease itself. Holding this decided relation to the subject under consideration, the question of bronchitis calls for special mention at this point. Acute bronchitis is not especially frequent or severe at the base of the Rocky Mountains. One is not very likely to "take cold" in an atmosphere as uniformly dry as this. Yet sometimes, during cold weather, there is liable to be a short season when influenza and "colds" are quite general.

Acute capillary bronchitis, especially in children, is aggravated by high altitudes. This would be expected from the increased labor required of the lungs.[1]

I hardly know what to write of chronic bronchitis, having become suspicious of it as a disease, from often finding it simply a symptom of further lung trouble, which had before attracted but little attention. It is much like the "catarrh," which is everywhere prone to attach itself to failing constitutions. Such bronchial,

[1] On this account, the indication to control the excited action of the respiratory organs is often followed in practice with improvement. This is done by firmly bandaging the chest of the little sufferer sufficiently to promote expectoration and prevent mucus, etc., being driven into the periphery of the lung.

catarrhal conditions, or rather the depreciated states which give rise to them, are most favorably influenced by an out-door life in this sunny climate.

The bronchial character of consumption, which is especially to be found among persons advanced in years, as well as in those of waning vitality, has to meet with and overcome the less adaptability of old than young people to the decided change to high altitudes.

As an illustration of how the dry rarefied atmosphere favorably affects that phase of chronic bronchitis, which so often precedes more seated lung disease, the following brief history is opportune: —

The last of October, 1876, a distinguished clergyman from Brooklyn, N. Y., came to Colorado by advice of physicians, many of whom had essentially agreed as to the diagnosis of the catarrhal condition which affected all the bronchial passages, with a special weakening and filling up of the upper part of the right lung. There was no family tendency to consumption, but he was one of those spasmodic, restless, and ambitious bodies who find it hard to *take life easy*, even at his age, forty-four years. Overwork and anxiety of mind had evidently much to do in breaking down a good constitution, bolstered up for a year or so by an average of about ten grains of quinine daily. For three years previous to his coming to Colorado, he had suffered occasionally with fever and ague, or pulmonary congestion, with chronic cough and general debility. He had been abroad, but had received little benefit from medication or the climate of southern Europe. Like such invalids, whose capacity for respiration is lessened by the clogging of the bronchial tubes with unnatural secretions, this gentleman felt the difference in elevation to a marked degree, and was much troubled by "getting out of breath" so easily. He was assured, however, that the defective bronchial passages would be again opened by the, so to speak, ex-

panded air, and the abnormal secretions therein be eventually dried up by its continued renewal. The prediction was verified, for in seven months, horse-back and mountain exercise having been somewhat indulged in, the rattling in slightly affected portions of his chest had entirely disappeared, and the imperfectly used upper portion of his right lung was rapidly being opened to complete and healthful respiration. The further experience and the death of this gentleman illustrates other phases and conclusions of the subject before us. It was noticeable to his friends the next fall that an eastern trip to his old home had been of no little injury to him. Soon after his return the peculiar cares of his calling (he should not have been allowed to preach another sermon), aided by a personal dislike to the kind of life which would have been best for him, started a train of pleurisies, with accompanying fever and nervous depression, which, with progressive emaciation and greatly quickened respiration, terminated in his death in November of the following year.[1]

Pleurisy, associated with a cough, as would be expected, is hard to bear, because the greater expansion of the lungs is accompanied with pain. It is chiefly met with in those whose lungs are defective, and not often as uncomplicated.

Nervous derangements of some sort are so often associated with pulmonary disease that the influence of this climate upon them requires a passing mention. A perusal of that portion of this work devoted to atmospheric

[1] A post-mortem examination verified previous diagnoses, there being an absence of any tuberculization whatever. Instead, the lungs were contracted and hardened, fibrous bands running through nearly all the peripheral portion, and sometimes through whole lobes, which, with pleuritic adhesions, were a positive check to the expansion of the lung. A pure case of fibrous phthisis, in my judgment, mainly dependent upon an overtaxed and constantly waning nervous force, for which, *in such a person* there was no permanent relief.

electricity; a recognition of the quickening of all the vital processes; and a knowledge of the results of increased blood pressure due to elevation; are all calculated to denominate the air of the foot-hill country of the Rocky Mountains as an *atmospheric stimulant.* It is undoubtedly true that much of the benefit received by consumptives — with nervous force so generally vitiated — is due to this stimulant. It is not, however, easy to accurately prophesy what this influence will be upon an incoming invalid, because of the various susceptibilities and idiosyncrasies of different nervous systems.

Much of the immediate influence may be grouped under the subject of *acclimatization.* Generally, new-comers, who are in health, become wonted to the change of 5,000 to 6,000 feet above sea level without any disagreeable feelings, unless it be in some a fullness in the head — perhaps with temporary headache and slight fever — in others an increased secretion from the nasal passages, for a week or so. But to most persons the first sensations are agreeable, the influence of the air being described as *exhilarating.*

With those whose respiratory organs are below the normal standard, however, the problem of acclimatization is a different one. I have thought that the spirometer, — through the knowledge it imparts of the amount of lung tissue a given patient can use, — might be considered, as I have employed it, a test of the appreciation of the change in elevation. For instance; if a third of one's respiratory apparatus is so implicated in diseased processes, that it cannot be used at full inspiration, then exercise which would call more than two thirds of the lungs into use at sea level, will be unbearable, because of the decrease in oxygen, at the base of the Rocky Mountains, where the air is a fifth rarefied.

Then, aside from the susceptibility of the nervous system, the character and acuteness of the diseased condi-

tions of the lungs, defective vital force, etc., the acclimatization is rapid and easy, or prolonged and uncertain, nearly in proportion to the amount of lung tissue involved, — advanced age being usually considered an unfavorable modifier. This general statement makes the acclimatization of invalids an accomplished fact after a residence of from two weeks to two, or even four months, at the end of which period a somewhat accurate estimate may be made of the effect to be expected from a prolonged residence in this elevated region.

When we come to consider the diseases of the nervous system, the frequent co-existence of complications has to be recognized as the rule for those who have thus far sought health in Colorado. If these diseases of the nerves are associated with, or dependent upon other dyscrasia, which the climate would probably rectify, then proportionate relief or cure could be expected. If they are purely neuroses — which are beyond this rectifying influence of associated malnutrition — then the symptoms might be expected to be aggravated by an atmosphere of very greatly lessened pressure. Such aggravating effect I have noticed in both corea and epilepsy, and the following has seemed to me[1] to be the general effect of the climate of Colorado upon nervous complications: *The more acute or severe the nervous symptoms the more of an aggravating nature is the effect of elevation.*[2]

A marked change in elevation, as from the East to

[1] "The Influence of the Climate of Colorado on the Nervous System," *Archives of Electrology and Neurology*, November, 1874.

[2] Dr. S. E. Solly, of Colorado Springs, remarks upon two cases of locomotor ataxia: "In these two cases of organic nervous disease, there did not appear to be any harm done by their coming to Colorado, and their general health was improved; but they were chronic, with little activity about them. In all acute cases, however, when actual change of nerve structure was going on, I have seen the symptoms aggravated by this climate." (Report to the State Medical Society upon *Climatic Influence on the Nervous System*, 1878.)

this country, has generally a salutary influence upon cases of nervous exhaustion — especially if associated with anæmia; also upon that class of overworked brains which, from the intensity of political, professional, and business life, is quite numerous these late years. This appears to me the case where, from too severe mental activity, the circular fibres of vessels within the cranium seem to have been overtaxed, and in consequence a passive congestion ensues. In these, the influence of lessened atmospheric pressure *gradually increased*, is in such marked contrast with the effect of a much greater atmospheric pressure, as shown in the congestion of cerebro-spinal tissue seen in the "caisson disease," that relief might be confidently expected. In this improvement the lessened tension on the cerebral circulation is, of course, greatly aided by new scenes, out-door life, and absence from harassing cares.

From what has been written of the stimulating or electric nature of the air at this altitude, it would be apparent in what manner some sensitive organizations might be influenced by the too stimulating atmosphere for them, among whom neuralgias and congestive headaches would prevail. I have in mind several ladies living in Colorado, whose nervous systems were well balanced before coming to this country, but who have here occasionally suffered with ill-defined neuralgias, mental distress, nervous headaches, etc.

In view of the opinion generally held, — that diseases are prone to assume an acute character in high altitudes; that the injurious effects of alcoholic stimulants upon the brain and nervous system are sooner felt, and with greater intensity than at sea level; that through the appetite there is a demand created to supply the greater waste of tissue; in view of all these considerations, it would be expected that the nerves would be more easily overtaxed in high altitudes. It may be so; but they are

as easily refreshed, for nowhere is sleep so sound and restful. This is insured greatly by the usually cool nights, and the freedom with which windows may be kept open, which is the more necessary because of the thinness of the atmosphere. Consumptives and convalescents from debilitating diseases are generally able to obtain here the tranquil sleep which is so essential for restoration to health.

There is a general impression — mostly unprofessional — that rheumatism is a prevalent disease in Colorado. I think this idea is greatly due to the fact that much of the so-called rheumatism may be more accurately classed under the head of neuralgia. Acute articular rheumatism neither seems to be prevalent nor rebellious to treatment. The popular belief as to the prevalence of rheumatism in the Rocky Mountain region need not prevent those chronically affected in eastern cities from coming to this section, for the change of climate, the alkaline state of the soil and water, or something, has tended to make the measure remedial. This has been verified in several instances of chronic rheumatism, gouty diathesis, etc., which have come under my observation.

GENERAL CONCLUSIONS GROUPED TOGETHER AND EXPRESSED SOMEWHAT DIFFERENTLY.

The following conclusions will serve to fix in the mind the results of our prolonged analysis of climate and consumption, more particularly as they relate to the question of altitude.

I. In the treatment of ordinary consumption, *cool* and *dry* climates very generally give more favorable results than those that are *warm* and *moist;* and both coolness and dryness are increased by elevation above the sea.

Conversely: As atmospheric humidity promotes an equable temperature, by the capacity moist air has of absorbing the heat of the sun's rays and preventing the

radiation of the same when once absorbed, therefore too much importance has hitherto been given to *equable temperature*, since it decreases with coldness and dryness and *generally presupposes a very humid atmosphere or a continuous moist wind.*

II. As the most favorable climatic qualities, the coolness, diathermancy, and dryness of the air, the amount of sunshine and atmospheric electricity, are increasingly found with increasing elevation and distance from the sea, *the localization of the ideal climate* we have been seeking is rendered easy in the Rocky Mountain plains and foot-hills, between the altitudes of four to eight thousand feet. This localization is further favored by the conformation of the country, the perfect drainage, the gradual approach to and the protection of the mountains, the character of the soil, the dryness of the winters, the scanty rainfall coming in health-giving showers during warm weather, the abundance of room and favorable localities, both within and outside of the foot-hills, — *altitude* and *exposure to the sun*, rather than *latitude*, deciding the question of locality.

III. The *modus operandi* of the curative effects of atmospheric pressure, lessened by one sixth to one fourth of that at sea level, seems to be that it acts upon diseased portions of the lungs through the increase of the respirations and the muscular action of the heart, thus promoting hæmatosis and a freer flow of the circulating fluid into and through the affected portion; which approximates a healthy circulation and prevents or brings to an end (when already existing) the stasis of blood which accompanies or causes actual disease.

IV. The generally accepted statement, that a change of climate and mode of life is favorable to the cure of pulmonary consumption *in proportion to its early adoption*, is rendered more positive if the invalid resorts to such high inland plateaus as those found in the Rocky Mountain regions, because *the results are more decided.*

V. The *stimulating effect* of high altitudes, associated with accelerated respirations and more powerful action of the heart, is opposed to the idea of *rest*, so necessary in the cure of most human ills, but constitutes a most important agent in arresting chronic phthisis.

VI. Generally speaking, *tissue change should be stimulated* or hastened in consumptives according to their ability to bear it; therefore the conclusion naturally follows — as experience in Colorado proves that altitude hastens tissue change — the better the resistance of the system to this change the more, generally speaking, is elevation indicated.

VII. Though change of occupation and out-door life are very important means of arresting consumption, yet the aid of an atmosphere of lessened pressure is worthy to rank with such hygienic measures as an *additional remedy:* a statement hitherto not accepted by many.

VIII. Lessened barometric pressure — twenty-five to twenty-four inches — being an important condition of successful climatic treatment, a resort to a *well-chosen elevated climate* should constitute part of the physician's advice to every consumptive, who can follow it, for whom the elevation is not specially contra-indicated.

IX. The *favorable* or positive influence of high altitude upon the progress of consumption, is best shown in the commencement of chronic inflammatory and hemorrhagic cases, and generally in fibrous phthisis in young and middle-aged subjects with little constitutional disturbance.

X. The *unfavorable* or negative influence of high altitude upon the progress of consumption, is mainly seen in proportion as the disease approaches or is complicated with the following conditions, which are intensified by an irritable nervous state and lack of desirable will-power, aided by the stimulus and hope of youth, *i. e.*, First, cardiac disease, if associated with increased labor

and abnormal activity of the heart: Second, the stage of softening, in acute cases, and with extensive deposit: Third, chronic third-stage cases with one third to one half of the lung surface involved in diseased changes, if the thermometrical and other usual signs of constitutional disturbance are present in a marked degree, or if hemorrhage from a cavity easily occurs; advanced age being generally considered a further unfavorable modifier.

XI. While the great majority of invalids may go immediately to the base of the Rocky Mountains (5,500 to 6,500 feet), in *serious cases* the approach to the elevated section should be *gradual*, according to the disturbance of the circulation, respiration, etc., at lesser elevations; this acclimatization, or the return of the pulse and respiration nearly to the usual standard, having there (say 2,000 to 4,000 feet) been first accomplished. And this caution is especially to be observed by those in whom hemorrhage or acute symptoms exist or are very easily excited.

XII. Generally speaking, the more seriously the respiratory organs, heart, etc., are impaired, the less is the elevation that will produce a given disturbance of them; therefore a lessened atmospheric pressure, with concomitant climatic variations, should be chosen, which is, in so far as possible, *adapted* to the physical condition of the lungs, state of nervous system, etc., in each individual case; or, to approximate a more concise conclusion, the ultimate prescription, so far as elevation is concerned, should be from one thousand to three thousand feet lower than that at which a somewhat prolonged residence would be injurious to a given invalid.

XIII. While desirable coolness increases the oxygen containing capacity of the atmosphere, altitude has a counter influence and necessitates an *active out-door life* to insure the best results; or again, the more an invalid

feels obliged to remain in confined apartments, just as the more he is deprived of his normal breathing capacity, then the more are extreme elevations unsuitable for him.

XIV. A somewhat *prolonged residence* is essential in the climate in which a certain consumptive finds his disease arrested; and a partial recovery generally necessitates a permanent residence, the return to the locality of the origination of the disease, except temporarily, being generally a dangerous procedure.

CHAPTER XVI.

PRECAUTIONARY MEASURES.

PULMONARY GYMNASTICS. — HEALTH LIFT. — MORNING EXERCISE. — COLD WATER. — DAILY GYMNASTICS. — EXERCISE *vs.* INACTION. — PREVENTION OF CONSUMPTION. — VALUE OF RANCHE LIFE.

THAT consumption has stages remediable by climate, and that the disease is more effectually arrested by that means than by any other, are very generally acknowledged. Notwithstanding these facts, however, we should not lose sight of other preventive and remedial measures, many of which have been emphasized in the previous analysis.

We come now to a phase of our subject which is so generally within the positive control of each individual, and at the same time so essential to his well being, that it seems to be a matter of personal appeal to all who need to substitute a free out-door life for their usual existence in "epidemic shades." Let Dryden hint the "ounce of prevention" in his words: —

> "Better to hunt in fields for health unbought,
> Than fee the doctor for a nauseous draught;
> The wise for cure on exercise depend;
> God never made His work for man to mend."

The means for preventing the accidents of insidious approach, which go far to make up the history of a consumptive's life, should be ever at hand and constantly in the mind of the consumptively inclined. This, too, should be the case however difficult it may be, and indeed is, for this class of invalids to keep always before

themselves and to follow the rules essential to their well being.[1]

Among these precautionary measures, both with or without a change of climate, are such rules and habits of life as will keep the lungs habitually and healthfully active; involving adequate ventilation of sleeping and living apartments by sunlight and pure air; daily out-door exercise, as by horse-back riding, or climbing, especially in the sunshine; nutritious diet; seasonable hours; and a contented state of mind. Probably few people are aware how close is the relation existing between emotional states and the development of disease. Instances are numerous, in the experience of the observing physician, of the positive injury to the consumptive which frequently ensues upon the sudden reception of startling intelligence, or as a result of continual despondency or harassing care. In such states of mind the respirations are longer and less frequent; there is an imperfect exhalation of carbonic acid and endosmose of oxygen; a feverish state is engendered, especially in the lungs; and the depressed and relaxed nerves, governing the whole economy, are rendered keenly susceptible to injurious impressions.

Some methods of pulmonary gymnastics seem so naturally associated with the climatic air cure we are considering, that no apology is necessary for inserting them

[1] We have to acknowledge the truth of the following statement from William Blaikie's valuable little work, *How to Get Strong*, published by Harper & Brothers, 1879, where may be found many valuable suggestions about daily exercise, apparatus for home gymnastics, and means suitable for a consumptive for developing the muscles of the thorax. "There is very little doubt but that a large majority of ailments would be removed, or rather, would never have come at all, had the lungs and also the muscles of the man had vigorous daily action to the extent that frequent trial had shown best suited to that man's wants."

For further research, Maclaren's *Physical Education*, and Hufeland's *Art of Prolonging Life*, by Erasmus Wilson, M. D., may be very profitably studied by the consumptively inclined.

here. The healthful activity of the lungs, which our ideal climate should insure, may be daily stimulated by the *health-lift*, or something similar to it, by which the respired air is sent to the extreme parts of the lungs and the blood makes a complete circuit of the terminal arteries and veins. Or a gymnastic experiment may be tried with benefit to simply weak lungs. It consists in slowly inhaling the fresh out-door air, night and morning, to the full capacity of the unrestricted chest, and while the air is retained, such gyrations of the arms and trunk should be practiced as will thoroughly distribute it to all parts of the lungs. Quick thrusts of the arms upward, forward, downward, and outward, are practiced by some; but the slow and largest possible circles made with the hands at the sides, moved forward, or backward and upward, seem to be equally effective. The daily practice also of dashing cold water upon the chest and arms, followed by a vigorous rubbing with a coarse crash towel, is frequently of the greatest benefit. If this rude imitation of, or the shower-bath itself, is not used — which is preferably stimulating to the skin and capillary circulation according to the force of the current of water — then quick, cold sponging, followed by the rubbing, should be daily practiced.

An excellent system of habitual gymnastics, which in some of its phases may be suited to almost any condition of chronic lung disease, is the following: *First:* From four to eight times a day — especially upon rising in the morning or retiring at night — walk into the corner of the room with the arms outstretched, the palms of the hands being against the two walls, quite as high as the shoulders, and breathe several times in that position. This can be repeatedly practiced at one trial, and then the process can be rendered desirably more difficult by standing two or three feet from the corner and letting the chest forward into it as before, long breaths being

taken while the chest is thus expanded. *Second:* This exercise may be still increased as follows: bending forward support the trunk by resting the hands upon the seats of two chairs about two feet apart, and straighten the body, with only the toes touching the floor. Then several times let the chest down between the chairs, as far as possible toward the floor, meanwhile breathing in that strained position. The agency of the fixed shoulders and muscles in expanding the apices of the lungs is apparent to every one, who understands their relation to respiration, and can be easily demonstrated by trying the experiment.

These pulmonary exercises should be conducted *with judgment*, lest, by overdoing them, unfortunate results ensue. The time required to master these exercises, till one can use them with impunity, varies from one to many months, according to the strength and condition of the invalid.

It must not be forgotten that the cessation of accustomed healthful activities of respiration favors the weakening of lung tissue more than is generally admitted, and such gymnastics must be *continued* or supplemented by an equivalent activity. This conclusion is emphasized by the following statement of Jourdanet: "*Exercise*, not overdone, but prolonged and carefully renewed each day, is the most essential thing in the hygiene of climate; while *inaction*, which favors muscular atrophy by stupefying respiration, kills."

The importance of an active out-door life has been so strongly impressed upon my mind by my Colorado experience, that the following conclusion comes to be almost a general rule for those whose lungs are already affected. *In so far as exercise in the open air is impossible, high altitude climates offer no decided advantage over those that are not elevated.*

The stimulation of respiration, circulation, assimila-

tion, and nerve power, induced by elevation above the sea, needs the accompanying physical exercise, such as healthy persons delight in, to harmonize and perfect this changed condition.

I am not prepared to combat the opinion Dr. Allbert lately expressed in the "London Lancet," that the majority of phthisical patients die of septicæmia, and that the arrest of this daily repoisoning is a primary object of treatment." On the contrary, bringing to mind my considerable experience with consumptives, who have had the suitable stimulation of the rarefied atmosphere and its accompanying changes, aided by the most healthful out-door life; especially noting the favorable progress of those with vicarious drains (as fistula, etc.), and the success of counter irritation; not omitting to mention the information imparted by the use of the fever thermometer, and I am impressed with the idea that if the destruction or decay of tissue (perhaps the focusing of germs) goes on faster than a stimulated nervous system and a life made active by respiratory and physical activity can arrest or throw off, then there is no hope of permanent cure. As before intimated, this unfortunate conclusion comes to many who seek, too late, the relief expected from an extreme climate, as at a great elevation.

In connection with the habits of living, which favor the arrest of existing pulmonary disease, comes an important topic, — *the prevention of consumption.* We only need to refer the discriminating mind to the conclusions of the foregoing analysis, — especially to the chapter on an altitude of approximate immunity from consumption — for evidence that there is prolongation of life, health, and happiness in Colorado and New Mexico, for thousands of those who are destined, by inheritance or acquired tendency, to die of consumption where they now live. The increased respiratory power due to elevation,

is accompanied by improved alimentation and capillary circulation. More perfect elimination of waste tissue and poisonous ingredients follows improved digestion; and life, while it may be more *rapid*, becomes more *perfect* for all who have to battle with taints of constitution. For the young, with tubercular and scrofulous tendencies, an active out-door life on the plains is especially to be recommended.

In seeking a home for the prevention of consumption, the possibility of the growing insalubrity of the air of cities should be taken into account. Experience in other sections of our own country, as well as in formerly reputed health resorts abroad, goes to show that, as new countries, health stations included, become settled and the density of population greatly increases, the conditions favoring consumption accumulate. We have no proof that the advantages of our ideal climate will counterbalance these growing insalubrious conditions; on the contrary, the rule already deduced, that the thinner the air is the more is out-door life and ventilation essential to healthful living, should also include the important consideration of the diathermancy of the air. Because of the increasing difference between the temperature in sunshine and shade for increasing elevations, we naturally come to the conclusion that a life in the sunshine is proportionately essential, according to the elevation — as well as the greater area of land per capita, larger living or sleeping rooms, etc. When we consider, in addition, the question of atmospheric electricity, we find all these favorable conditions are quite likely to be furnished by what is called, in Colorado, "ranche life,"— probably the most healthful existence possible for a consumptively inclined youth.

These ranches, for two reasons, are widely separated from each other; first, because they must be in some river bottom or near springs, which, in this dry country,

are infrequent; and, second, on account of the short buffalo grass, which, for sustaining cattle, necessitates a larger amount of land per capita than is required in most low-lying countries. Again, the necessity of irrigation, because of the sandy and porous soil and small precipitation of rain, does not favor extensive cultivation of the soil. These conditions, especially the first mentioned, induce a segregation and sparcity of population, so that those who believe, as some do, that consumption is mainly caused by "rebreathed air," must consider such dry pure air invaluable. Also the rural habits, the plain and nutritious diet, not omitting the particularly rich milk, — perhaps somewhat charged with alkali, in alkaline sections like these, — and the early hours of retiring and rising, all contribute to make ordinary ranche life healthful. The representative "cow-boy" of the plains, who is "at home" all day among cattle, living much of the time astride the "bucking broncho," is the last person in whose lungs we expect to note the advent of tubercles.

CHAPTER XVII.

CAMPING OUT.

"Nor rural sights alone, but rural sounds,
Exhilarate the spirit and restore
The tone of languid nature." — COWPER.

HINTS FOR INVALIDS. — ELEVATION WITH DISCRETION. — CAMPING OUT. — SUNLIGHT. — SUNSETS. — CAMP SCENES. — RESULTS. — FLOWERS OF COLORADO. — "OUTFIT." — CLOTHING. — BEDDING. — HOW TO CAMP OUT WITH LITTLE EXPENSE. — CAMPING PARTIES. — ESTIMATES. — ROUTES OF TRAVEL.

THUS far in this discussion of the health-giving qualities of the climate of the Rocky Mountain region, and in the advice offered to those who seek it to build up failing health and strength, particular stress has been laid upon the necessity of exercise in the open air, especially enjoining discretion upon those with diseased lungs, warning them not to attempt to do too much at first, nor to scale too great heights before they have become accustomed to the elevation.

Incautious invalids, stimulated by the intoxicating air, and exhilarated by the consciousness of returning strength, immediately upon their arrival in Colorado set out for the hills and are allured on and up into the mountains until they become exhausted before they are aware; while some, with a liability to hemorrhage, suffer from an attack, lose ground, and become discouraged.

It is this lack of common sense and discretion on the part of the invalid, which has sometimes brought the climate into undeserved disrepute. The sick come here too late; or, having arrived, attempt so much more than

their strength will permit, that all the good effects of the climate are counteracted.

It is not claimed that the climate of Colorado, which, as Robert Collyer says, is a "wonder and delight," can accomplish impossibilities: It cannot restore the dead to life, nor will it probably cure the consumptive who insists upon climbing Pike's Peak the week after his arrival; but it *is* asserted that, if an invalid suffering from incipient or not advanced consumption seeks this climate for the purpose of taking advantage of its perfect aero-hygienic conditions, and follows a regimen dictated by discreet judgment, *arrest of the disease, or complete restoration to health may, probably will, ensue.*

Let the invalid tourist, on his arrival in Colorado, remain ten days or a fortnight in one of the lower towns, — Boulder, Denver, Pueblo, or Cañon City, as the case may be, — and from thence, if desirable, advance gradually, by rail, horseback, or wagon, to higher levels, as the enfeebled lungs accustom themselves to the rarefied air.

One of the best methods of gaining the altitudes, and of obtaining the highest possible benefit from air, sunshine, exercise, and elevation, is by *camping out.* In the pre-railroad days, when all who crossed the plains were compelled to do so in a wagon, or with an ox-team, the degree of improvement was greater among the consumptive invalids than it is at the present time, because then all phthisical patients, even though they left home upon a mattress, *must* live in the dry, open air, sleep under the stars, and often *do their own cooking.*

The latter consideration is, in a hygienic sense, no unimportant factor of the successful result of a camping-out trip. Under such compulsory circumstances those with limited means must have a fairer chance of recovery than those who have plethoric purses, for the simple reason that the poorer individuals are forced to shift for

themselves, to exercise, — and, what is still better, have no time to think of themselves or dwell upon their own ailments. Instances are numerous in the experience of old residents, of those who left the Missouri River well-defined invalids, and, traveling in wagons across the plains, reached the base of the Rocky Mountains apparently cured.

The charm of this unique country lies in its variety, its capability of developing new and interesting features, and the novel experiences it offers wherever one may turn. The mountains, with their beautiful parks and cañons, are accessible from most of the first stopping-points upon the railroad, by less than a day's ride.

Armed, equipped, and *outfitted*, a party may follow one of the creeks up a rugged cañon, camping at nightfall upon the banks of the stream beneath the crags; finally they reach a park above, where they pitch their tent in a wooded vale near a tumbling mountain stream, or,—

> "By shallow rivers, to whose falls
> Melodious birds sing madrigals."

and spend weeks delightfully, sketching, botanizing, geologizing, fishing, or hunting, but always and ever recuperating.

This mode of life serves the double purpose of opening an avenue to health and of furnishing pleasurable novelty, having a tendency to distract the mind of the invalid from himself, which, combined with the incentive and *determination to get well*, is half the battle. In no other way can the tourist enjoy to the full Colorado's electric air, clear sunlight, unsurpassed sunsets, and beautiful moonlight. As one has wisely said, "No one need be afraid of the sunlight of Colorado. It has all the beneficial effects of sunlight in other countries, with none of its enervating effects common elsewhere. *Bask in it*, enjoy it all you can, for few have as yet fully appreciated the

beneficial effect of the chemical action of sunlight on the blood."

As for the sunsets of Colorado, they are, as we have said, truly unsurpassed. No artist, without incurring the imputation of exaggeration, could do full justice to the vivid tints and gorgeous colors which bathe our western skies after the sun has sunk below the mountain horizon. Beyond the glistening summits of the snowy range, —

> "Parting day
> Dies like the dolphin whom each pang imbues
> With a new color as it gasps away,
> The last still loveliest, till — 't is gone — and all is gray."

Ladies and delicate invalids who live at home in perpetual fear of that baneful influence, *the night air*, may, as there is no dew, sit out late in the evening with impunity, the air of midnight being generally as harmless as that of noonday, so far as moisture is concerned. And after a day spent in the pleasure, unwonted experiences — discomforts, perchance — of camp life, how delightful is the interchange of thought and the report of the "day's doings," about the evening camp-fire; how the clear night air vibrates with song and laughter, while the stars above look mildly askance; how sweet the rest, how sound the sleep on Nature's couch, — elastic mattresses of fir, pine, or hemlock boughs! And how lasting and grateful is the memory of these scenes in after years! When the actor therein has returned to the sober routine of every-day life, how vividly he recalls the picturesque group around the sparkling logs, the ready wit of one, the operatic strain, the comic song, the allotted tale, from another, or, perhaps, the long-drawn-out *yarn* of some chance mountaineer!

To see one of these camping parties coming in from the mountains after "*roughing it*" for a month or two, is sufficient to convince the most incredulous of the utility

of the *régime*. They left the plains thin, languid, and pallid; they return, bronzed and rugged, with elastic tread and full chests, gladly owning that to the experiences of camping out they owe a new lease of life. It is an opinion which I have previously expressed, that to the fact of *sleeping upon the ground* in the pure dry air, amid the balsamic exhalations of this primitive resting-place, may be attributed much of the happy results of camping out. The system, roused by the tonic influences of earth and air, wakes into new life and vitality, and morbid feelings and conditions wear away.

Camp life too, affords one who has a taste in that direction, an ample opportunity to make a study of the mineral and floral wealth of Colorado. This region contains such a diversity of rocks and ores, that in a short time a fine cabinet of interesting and beautiful specimens can be collected. Enough cannot be said of the flora of Colorado. Flowers in summer grow in riotous luxuriance everywhere; at times the plains are rich with them, from the yellow sunflower, the scarlet cactus, or blue larkspur. In the mountains, the dainty little harebell nods from every crevice; wild roses, the scarlet cypress, jessamine, the graceful columbine, and flowers innumerable, are found following the season up the heights.

But while we are picturing the delights of camp life, we must not allow ourselves to fall into the mistaken idea that everything connected with camping out is artistic, æsthetic, and comfortable. On the contrary, there is always a certain amount of common-place drudgery to be undertaken; occasional deprivations, hardships, and showers occur; but those who are on the invalid list must comfort themselves under such circumstances by the reflection that all these disagreeable realities serve to discipline them to a state of better health and renewed vigor. To do all that is possible to insure the

pleasures of a trip beforehand, however, the matter of *outfitting* must be carefully attended to.

The word "*outfit*" is a technical term, by which one designates the wagon, tent, horses and accoutrements of a camping party. It may vary greatly, according to the number and circumstances of the campers, the length of time they intend to be out, their destination and peculiar wants. In addition to the outfit proper, each individual of the party should be provided with plenty of warm under flannels, wraps, etc., a pair of blankets, and a comfort or India-rubber blanket for each person; better than either of the latter, however, is a buffalo-robe, which makes a comfortable bed, even more so if doubled over pine or hemlock boughs. Very delicate invalids might provide themselves with thin hair mattresses, three feet wide by six in length, and a feather pillow. Let the ladies of the party wear warm flannel suits, perhaps fashioned *à la turque*, so that they may, if necessary, mount their ponies with ease, and ride them astride, a much safer and more convenient way of traveling by mountain trails than the ordinary method.

A mode of life somewhat similar to camping out can be undertaken by a party of two, who evidently intend to subsist mainly by stopping at ranches or village hotels on the way. They go on horseback leading a pack-horse loaded with blankets, shelter-tent, and temporary provisions in case of emergency; or they may calculate to stop at such places altogether, in which case the pack-horse is discarded, and the blankets are strapped behind their own saddles. If ranche people are properly approached, they are generally very friendly, and are quite willing to share their humble fare with tourists. This plan of traveling through the country on horseback is an excellent one, especially if the season be unpropitious, the contemplated journey too short to warrant the expense and

trouble of outfitting, or the invalid too weak to inure himself to the life of "roughing it."

But the true way to camp out is to get together a party of people whose congeniality of disposition and unity of purpose are sure to make this *al fresco* life pleasant. We might digress to note here that camping out together is perhaps the strongest test of friendship which could be suggested. Individuals, dependent on one another for mutual favors, are thrown together day after day under circumstances which often try both tongue and temper. As a consequence of these intimate and trying relations, many a long-time friendship has been rudely ruptured for some trivial cause; while the foundations of another which is to endure for years have been firmly laid. As for lovers, the experiences of camp life afford innumerable opportunities for quarrels, and perhaps for reconciliations, as it is written, —

"Amantium iræ amoris integratio est."[1]

To return to the subject proper, a party of four, six, or eight, can go out with one outfit and a driver, averaging the expense of their common household on their return. Or, if from necessity they wish to save expense, they may furnish their own team or hire one. A covered Bain, Shuttler, or Studebaker mountain wagon, perhaps (camp stove and mess chest attached), with two horses, or fast walking mules, may be obtained for two or three dollars a day. Two of the party can sleep in the wagon, shelter-tents being purchased for the others. They invest in tin dishes, Dutch oven, frying-pan, etc., provide themselves with provisions according to the cheaper estimate hereafter given, and find, upon balancing the account, that the amount *per capita* is very moderate.

Again, a party of six, including ladies, perhaps, may

[1] The quarrel of lovers is the renewal of love.

wish to camp out together, some preferring — as I most decidedly should — to go on horseback. As they intend to remain out six or eight weeks, they may like to buy their own team. A covered second-hand wagon may be purchased for about eighty dollars, or a new one for one hundred and fifty, and a pair of suitable draught-horses for fifty to one hundred and twenty dollars each; ponies or saddle animals will cost from thirty to seventy-five dollars apiece. These may be disposed of in the fall for one half to three fourths of their original cost.

Or, the camp-wagon with a driver, who will serve as a general attendant about the camp, may be secured for four dollars a day, and the four ponies for two or three dollars extra. Thus two to four persons can at all times ride on horseback, and the rest of the party remain in the wagon at pleasure. Those upon horseback may skirt around in interesting by-paths, explore a neighboring cañon, delay or go on in advance to tempt the wily trout, while the wagon, heavily loaded with good things, makes the usual day's journey of twenty to thirty miles.

Again, a party of four, six, or eight gentlemen may wish to extend their trip beyond the roads usually traveled by heavily loaded teams. They intend to be out several weeks, and are all on horseback. The provisions are of the simplest kind and are carried on *burros* or pack-horses, — one pack-horse carrying provisions sufficient for two persons for four or five weeks, and longer if the tourists are experts with the rifle and fishing-rod. This party is prepared to surmount mountain passes by difficult trails, or to camp out before any unusual obstacle which impedes its farther advance, overcoming which, progress is made. Usually, however, it is preferable to stop over night in some genial spot below the "timber line."

I have now sketched in the rough, plans by which

parties wishing to go out camping together can do so. The accompanying estimates may be of use in determining the cost of an outfit.[1]

ESTIMATES, — ONE MONTH'S PROVISIONS FOR ONE PERSON.[2]

	No. I.	No. II.
20 to 30 lbs. Flour	$0.60 to $0.90	$0.70 to $0.90
1 to 1½ lbs. Rio Coffee	.25 to .30	Java, .45 to .60
4 lbs. Sugar	.40 to .50	.40 to .50
20 to 40 lbs. Ham and Bacon	2.40 to 5.00	2.50 to 5.00
3 to 5 lbs. Beans	.15 to .25	.15 to .25
2 to 4 lbs. Rice	.20 to .40	.20 to .40
½ lb. Tea	.25 to .50	.30 to .50
5 lbs. Oatmeal	.25 .25	.25 .25
1 quart Syrup	.20 to .30	.25 to .40
5 lbs. Dried Fruit	.50 to .75	.65 to .75
3 lbs. Lard	.35 .35	.40 .40
Salt and Pepper	.15 to .20	.15 to .25
1 to 2 lbs. Crackers	.10 to .20	.10 to .20
1 Bottle of Pickles	.35 to .45	.35 to .50
1 to 2 Cans Yeast Powder	.30 to .60	.30 to .60
2 Bars of Soap	.10 to .15	.15 .15
1 Box of Matches	.05 .05	.05 .05
½ lb. Candles	.10 .10	.10 .10
5 lbs. Corn Meal	.10 .10	.10 .10
10 lbs. Potatoes	.20 .20	.20 to .25
1 lb. Cheese	– –	.15 to .20
1 lb. Butter	– –	.25 to .30
12 Cans of Fruit	– –	2.25 to 3.50
6 Cans Potted Meats	– –	2.00 2.00
French Mustard	– –	.20 to .30
Totals	$7.00 to $11.55	$12.60 to $18.45

[1] Though Denver is the principal wholesale point of the Rocky Mountain section, some may prefer to start from Pueblo, Colorado Springs, Boulder, Cheyenne, or the terminus of some one of the mountain railroads.

[2] These estimates are compiled from prices furnished (summer of 1879) by Salomon Bros. and Wolfe Londoner, grocers, Denver. The figures are made up so as to present about the average of two separate lists furnished. They, however, serve only as a general guide, as prices must necessarily change from year to year.

No. III.

Twenty to thirty lbs. flour, $0.80–.90; 5 lbs. oat meal, .25–.50; 5 lbs. corn meal, .15	$1.20 to $1.55
One and a half lbs. coffee, $0.70–.75; ½ lb. tea, .50–.75; 4 lbs. loaf sugar, .56–.60	1.76 to 2.10
Ham and bacon, $2.25–5.00; 3 to 5 lbs. beans, .15–.25; 4 lbs. granulated sugar, .44	2.84 to 5.69
Four lbs. rice, $0.40–.50; baker's chocolate, .50–.55; 12 cans of fruit, 3.25–3.50	4.15 to 4.55
Twelve cans of vegetables, $2.25–2.50; 6 cans potted meats, 2.00–2.10; 3 cans jelly, 1.20	5.45 to 5.80
One bottle olives, $0.35–1.00; 2 to 3 cans preserves, 1.25–1.50; 1 bottle sauce, .40–.75	2.00 to 3.25
One lb. to 1 box fancy sweet crackers, $0.25–.75; 1 jar honey, .35–.60	.60 to 1.35
One pine apple cheese, $1.00; 2 cans yeast powder, .70	1.70 1.70
One box matches, $0.05; ½ lb. candles, .10; 2 bars soap, .20	.35 .35
Salt and pepper, $0.15–.30; 2 cans soup, .80; 5 lbs. potatoes, .15–.25	1.10 to 1.35
Five lbs. onions, $0.20	.20 .20
	$21.35 to $27.89

For the convenience of different-sized parties these estimates are made out approximately for one person for one month, which gives a basis for determining the total expense. These estimates — Nos. I., II., III., — are given to enable parties to make out a list to their liking, and thus graduate the expense to the length of their purses. However, list No. I. is more especially suitable for parties expecting to go on horseback, with pack animals to carry their provisions, etc. Wines and tobacco; and grain for horses (which would be needed if consecutive days' journeys are to be made) are not included.

TENT, BLANKETS, ETC. — OUTFIT FOR FOUR PERSONS.[1]

	Class I.	Class II.	Class III.
Tent	$5.50	$12.50	$19.00
Table[2]	–	3.00	4.50
Chairs[3]	–	4.00	7.00
Beds[4]	–	8.00	12.00
Rubber Blankets	5.00	5.00	6.00
Tent Carpet[5]	–	2.40	3.50
Blankets	6.00	10.00	16.00
Total	$16.50	$44.90	$68.00
Cost per capita	4.13	11.22	17.00
Dishes and cooking utensils per capita	2.00	4.00	7.50

ROUTES OF TRAVEL.

The routes of travel by railroad, for Colorado-bound tourists, would naturally vary somewhat, according to the point of ultimate outfitting and destination, though up to the present time the great majority have come first to Denver. However, the matter of expense of travel does not greatly vary, as the different railroads coming west are so connected that almost any point can be reached by any one of them. For instance, leaving New York or an eastern city by one of the principal trunk lines, either Chicago or St. Louis may be reached.

[1] This list is furnished by Morrison, Van Vliet & Co., Denver.

[2] A folding table made especially for the purpose, not positively necessary, but very convenient.

[3] Class II., cross-legged, canvas covered stool, $1.00 each. Class III., reclining chairs (folding), $1.75 each.

[4] Folding canvas beds; Class II., for two double beds; Class III., for four single beds.

[5] Carpet of canvas, not essential, exact size of tent, with loops to fasten to the bottom of the tent, making tent much more cleanly. Some parties, who go into camp for the season, have for their tent an elevated board floor which is covered with a carpet.

From the latter city three roads — the Chicago and Alton, the Kansas City and Northern, and the Missouri Pacific — run to Kansas City. From Chicago there are four good roads: the Chicago and Northwestern, the Chicago and Rock Island, and the Chicago, Burlington and Quincy, connecting in a joint depot with the Union Pacific at Council Bluffs, and thence with the Colorado Central and Denver Pacific at Cheyenne; while the Chicago, Burlington, and Quincy, the Rock Island, or the Chicago and Alton, connect at Kansas City with both the Atchison, Topeka, and Santa Fé, and the Kansas Pacific. The Atchison, Topeka, and Santa Fé connects with the narrow gauge Denver and Rio Grande at Pueblo, which runs direct to Denver.

Along the eastern base of the Rocky Mountains, and extending into them through different cañons, almost any point can be reached by the extensions of these roads or connecting railroads and existing stage lines.[1] The routes for campers out, after they have out-fitted, are so various and often changed or prolonged after starting as to be better decided upon by the parties immediately concerned, in view of their object in going, the method of subsisting, time they can spend in the mountains, etc.

[1] The southern extensions of the Atchison, Topeka, and Santa Fé southwest into New Mexico to the Rio Grande River at Albuquerque, and thence south to El Paso; the southwest extension of the Denver and Rio Grande from the Rio Grande River at Alamosa, to the San Juan River, and thence to Silverton and the San Juan mines — another branch built from Cañon City up the Arkansas River beyond Leadville; the Denver, South Park, and Pacific running southwest from Denver, through the Platte Cañon towards Fair Play, Leadville, and into the Gunnison Country; and the Colorado Central from Denver, *via* Golden, through Clear Creek Cañon to Central, Idaho, Georgetown, etc.

ADDENDA.

THE rapid growth of this Western country, the extending of railroads and the building of towns, necessitates a few corrections and additions, mainly to the chapters on Mineral Springs and other Health Stations.

Page 37. — The "Evergreen House" at Morrison is now changed in name to the "Swiss Cottage." It is to be kept open winter and summer, more particularly for the accommodation of invalids, who there find a healthful home, pleasantly located in the foot-hills, and convenient to Denver.

The Springs at Deansbury, also reached by the Denver and South Park Railroad, are becoming known to be of very decided medicinal qualities, the waters acting as an efficient saline aperient, or cathartic. The location is a rocky gorge in the Platte Cañon, twenty-seven miles from Denver. The hotel there is well spoken of, the elevation is not extreme, and there are abundant opportunities to put in practice the *climbing* treatment.

This South Park narrow gauge road is now completed beyond the Chalk Creek Hot Springs, now called the Haywood Springs, at Hortense, and it is expected it will soon reach Gunnison City and the country of the Western slope, where there are more hot springs somewhat similar to those on this side of the range.

Leadville is also reached by this road; near which thriving city there are some soda springs, where a house sufficient to accommodate fifty people has been built for the convenience of visitors.

Page 39.—MANITOU SPRINGS. This "Saratoga of the West" is now connected with the outside world by the extension of the Denver and Rio Grande Railroad from Colorado Springs. A hotel and some cottages have been built at Manitou Park, about fifteen hundred feet higher up in the mountains, particularly for the accommodation of tourists and invalids in summer.

Page 42. — PUNCHA SPRINGS. These hot springs are six miles from the new town of South Arkansas, which is located on the Denver and Rio Grande Railroad above the wonderfully picturesque "Royal Gorge," the grand cañon of the Arkansas River.

This railroad is built up the Arkansas Valley to and beyond Leadville, with Breckenridge and the Eagle River country as the principal objective point. The junction of this branch of the Denver and Rio Grande with the Denver and South Park Road is at Buena Vista, a new town at the mouth of Cotton-wood Creek. The springs named after this creek are six miles from Buena Vista, at the base of the mountains. The hot water which bubbles out of the earth here is very similar in temperature, etc., to that found at the Springs of Puncha Pass and Hortense. Cotton-wood Springs are reached by stage from Buena Vista, and there is a convenient little hotel and suitable bath accommodations there.

Both the narrow gauge roads carry passengers to Twin Lakes, at which delightful summer resort there are now several hotels built. The ample accommodations here for visitors, and the ease with which these beautiful mountain lakes can be reached, will make this a very attractive spot for invalids in summer. It must be borne in mind, however, that the considerable elevation of the place is not suitable for all consumptives.

Page 44. — The Southwestern branch of the Denver and Rio Grande Railroad will soon be running through the San Juan to the Animas Valley, where, at about six thousand feet above the sea, the new town of Domingo is located. This particular section of Colorado gives promise of being an attractive place for invalids because of its genial climate, due to

its southern exposure and latitude, and because a warmer or cooler climate can be easily obtained, as it is not far to either lower or higher elevations.

The line of the Denver and Rio Grande road is south of the wonderful Pagosa hot springs, but it is intended to build a branch road there. Then, the wonder of their cures is expected to make them rival the Hot Springs of Arkansas. The bracing climate among the foot-hills, which are there covered with large pine trees, will undoubtedly help to verify this prediction.

Page 47. — The Atchison, Topeka, and Santa Fé Railroad has of late made good progress to the south, being completed to Santa Fé and Albuquerque. It is now nearing El Paso, Mexico, with a prospect of reaching, before long, a western terminus at Guaymas, a Mexican seaport town on the Gulf of California.

The foresight and enterprise of the projectors of this road are opening to the invalid world a choice of a winter home in regions which have peculiar advantages to certain classes of cases for whom the more stimulating winter climate of Colorado is of doubtful utility. In the Mesilla Valley, for instance, the isothermal line of 64° Fahr. takes a turn north up to the elevation of four thousand feet above sea level, while the climate ranks amongst the most extreme for dryness and continuance of sunshine.

This increased temperature lessens the influence due to elevation, so that the most cautious plan as to climate, for some cases characterized in this work as doubtful or serious, can be carried out. Many of these may afterwards tentatively try the higher and more stimulating altitudes. Especially will such a course be made feasible for the invalid when the Southern Pacific Railroad, running past El Paso, Mexico, is completed to the Gulf of Mexico. Then some of the advanced consumptives, who could only otherwise reach high altitude with risk, can spend the winter months most profitably in Southwestern Texas, and in reaching the sunny Mesilla Valley in New Mexico. There, encouraged by returning health and strength, some of these will still further improve by going, the following summer, north, and up into the rarer air of the Rocky Mountain foot-hills in Colorado.

It is to be hoped that the same kind of enterprise that has laid the iron rail down the valley of the Rio Grande, will then, in well-chosen localities, supply suitable accommodations for invalids.

Page 144. — The inquiry has repeatedly been made: "What effect has the climate of Colorado upon nasal catarrh?" Generally speaking, the influence is unfavorable, in so far as the catarrh is not a symptom of some weakness. There seems to be here a local cause for a variety of catarrh which may be characterized as *dry;* evidently produced by the irritating influence of the unusually dry air upon the Schneiderian membrane. This form of catarrh does not appear to have any serious result, however. Many instances are known of *moist* catarrh being cured, or favorably changed after the sufferer had removed to Colorado. This conclusion, I think, in a measure, substantiates the general belief held by physicians, that this condition is mainly a symptom of depreciated vitality or vitiated blood. For this, the climate of Colorado often proves beneficial.

TABLE OF GENERAL REFERENCES.

It can be seen that the author of a work of such a peculiar nature as the preceding might be burdened with all kinds of inquiries from all sorts of people. To avoid such mistakes, — for a physician has neither the time nor inclination to fully reply to such unreasonable demands, — I am permitted to refer to gentlemen, who, because of their avocations, are better suited to answer such inquiries and on whom the reader is at liberty to call (not omitting, as some do, to enclose a stamp to pay return postage). It is a pity there is no State Board of Emigration in Colorado, which, through its paid secretary, could mass a large amount of such work and correspondence, and disseminate much information to inquirers over the land. Till the time arrives when the legislators of the State appreciate the need of thus establishing a Board of Emigration, it might be a good idea to direct such correspondence as has reference to any given county in the State, *To the State Representative of—— County, Colorado* (directing to the county seat if known).

On matters of *Education* reference can be made to *Prof. Aaron Gove*, Superintendent of Schools, Denver; to the State Superintendent of Public Instruction, Prof. J. Shattuck, Boulder; to the County Superintendent of Schools in any county; Colorado College, Colorado Springs; University of Denver; Rev. Earl Cranston, Secretary, Denver; Brinker's Collegiate Institute, Denver; Colorado State University, Boulder; Jarvis Hall (for boys), Wolf Hall (for girls), Denver. (The annual report of the Board of Education of Denver contains valuable information for many inquirers.)

On Stock-raising. Address Secretary Stock Growers' Association, Denver; Secretary of the Southern Colorado Stock Grower's Association, Pueblo; or Secretary Rocky Mountain Wool Growers' Association, Denver.

On Agriculture. Secretary State Board of Land Commissioners, Denver; Secretary of Weld County Farmer's Institute, Greeley; Colorado Agricultural College, E. E. Edwards, President, Fort Collins; Colorado Bureau of Agricultural Information, Denver.

On Mining. Address J. Alden Smith, State Geologist, Denver. Inquire of some of the State officers, Denver; or State Representatives of the respective mining counties; Colorado School of Mines, Golden; Colorado Bureau of Mining Information, Denver; "Rocky Mountain Mining Review," Denver.

On Business generally. The Secretary of State, or Executive Department, Denver; Secretary of the Board of Trade, Denver (annual report); Secretary of the Colorado Springs Company; annual statements (January 1st) in newspapers, as Denver "Tribune," or "News;" Colorado State Directory, Denver, or Fossett's "Colorado," to be obtained of book dealers generally.

On House Rents, Boarding, etc., J. M. Berkey & Co., Denver, or other real estate firms; Secretary Colorado Springs Town Company; any town clerk; or city clerk, Denver.

General Offices of Railroads. Atchison, Topeka, and Santa Fé, Topeka, Kans.; Kansas Pacific, Kansas City, Kans.; Union Pacific, Omaha, Neb.; Colorado Central (U. P. Division), Omaha, Neb.; Boulder Valley, Kansas City, Kans.; Denver Pacific (Cheyenne Div. K. P. Railway), Kansas City, Kans.; Denver and Rio Grande, Denver, Col.; Denver, South Park, and Pacific, Denver, Col.

[The first five of these roads, also, have offices in Denver for the transaction of Colorado business.]

[Board on ranches can be had from $5 to $10 per week, according to accommodations, locations, etc. At boarding houses, $6 to $12, and at hotels, $8 to $15 per week.]

INDEX.

PAGE

Absolute versus relative humidity 59–61
Acclimatization, difficult according to age 130
when generally effected 146
Activity of respiratory organs in Rocky Mountain sections . 103
Activity of functions influenced by heat 56
Adaptation of climate to physical states, etc. 152
Addison, Dr. Thomas, inflammatory nature of phthisis . . . 2
Advanced cases, too much so for elevated climates 94
Age, classification as to. (See Table XV.) 128–131
Agriculture. (See Table of References.) 177, 178
Aiken, S. C., dry, bracing atmosphere of 13
Air, difference in weight between dry and saturated . . . 58
Alpine climates 18
Altitude, high, chapter on 18–25
approximate immunity of 95
physiological effects of 81–94
American life insurance companies, deaths by consumption. (Tables I. and II.) 4
Anæmia, "by the imperfection of the respiratory act" . . 85
Anahuac, the plateau of, in Mexico, agreeable climate of . . 21
infrequence of phthisis there 21, 99
Analysis of the attributes of high altitude climates 52
of 350 years spent by 202 consumptives in Colorado . 117–131
as to stages of disease. (Table XIII., p. 119.) . . 117–121
as to nature of disease. (Table XIV., p. 122.) . . . 121–125
as to pulmonary hemorrhage. (Table XVI., p. 135.) . 134–139
as to inheritance 116
Andean ridge of Quito 20
Animas Valley, its genial climate, and its attractions for invalids 174
Annual means and ranges of temperature 54, 55
Antelope Springs, Antelope Park 43
Approximate immunity. (Chapter XI.) 94–102
Arizona, climate and topography of 13, 21
infrequence of consumption there 99
Arrested phthisis, Dr. Austin Flint's record 131, 132
Asheville, N. C., sanitarium at 14
Asia, high altitude health resorts 19
Asthma, record of 117 cases in Colorado 105

Asthma, cases illustrating climatic influence 107–109
complicating emphysema 113
cures in Colorado. (Chapter XII.) 104–111
hay, Dr. George M. Beard's researches 106
its cure in Colorado slighted by authors generally . . 104
modus operandi of climatic influence 109, 110
recurrence of, after return to low altitudes 109
Atmospheric electricity. (Chapter IX.) 74–77
germs decrease with elevation 100
pressure decreased — how curative 150
pressure lessened, in treatment of asthma 103
stimulant 146
Aussee, climate of 117

Balloon ascensions, records of pulse, etc., during 81
Croce-Spinelli 62
Gay Lussac 63
Glaisher's 53
M. Gaston Tessandier, and others 82
Balsamic regions of Georgia 13
Barometrical observations 28
Beard, Dr. George M., investigations as to hay asthma . . 106
Bennett, Dr. James Henry, post-mortem evidences of consumption 6
loss of nervous energy 76
on nature of disease, etc. 121
Bermudas, Bahamas, and Canary Isles, climate of 12
Bert, Paul, experiments on birds 87–89
Bethesda Spring, Waukesha, Wis. 30
Boarding-houses, rents, etc. (See Table of References.) . 177, 178
Bolivia, great plain of 20
Boulder, Colorado State University 35
Braun, Dr. Julius, on climatic cures at Königswarth and Eaux Bonnes 16, 17
Brazil, medium altitude climate 16
Bronchitis, acute and chronic 143
chronic, complicating emphysema 112
Bronchial consumption 144
Buchan, Alexander, on atmospheric electricity 74
Buena Vista, Colorado, location, and railroad and stage connections 174
Buffalo-grass, eastern limit of dry climate 15
characteristic of dry elevated plains 15
Bureau for agricultural and mining information 177, 178
Business generally. (See Table of References.) 177, 178

Camping out. (Chapter XVII.) 161–171
Camping parties of different kinds 166–168
estimates for provisions 169, 170
estimates for tents, blankets, etc. 171

Camp life, memories of, etc. 164
Cañons in Colorado 24, 25, 174
Cañon City, medicinal springs at 40, 41
Cañon Creek, hot soda and bitter salt springs 45
Carlisle Springs 48
Catarrhal group of consumptives. (See Table XIV., p. 122.) . 123–125
Cauterets, medium elevation 17
Chaillé, Dr. S. E., the climatotherapy of consumption . . 14
Chalk Creek Springs 32, 42, 173
Change of climate, its early adoption 150
Chart, the Chest Examination . . . . See Preface to 2d Edition.
Chest examinations . . . . . See Preface to 2d Edition.
Chicago Lakes, how reached from Idaho Springs 35
Chihuahua, climate of 16
Chronic tuberculous group of consumption. (See Table XIV., p. 122.) 123–125
Circulation, capillary, accelerated by respiration 92, 93
Clear and fair days, number of. (See Climatic Map.) . . . 28
Clear Creek Cañon 34
Climates of low elevations 8–13
Climatic map of the eastern slope of the Rocky Mountains. (Chapter IV.) 26–28
treatment of consumption in Colorado. (Chapter XIII.) 114–140
Cold, physical effects of 58, 74
Colorado, extent and climate of 23
climatic treatment of consumption in 114–140
effect of climate upon asthma, record of 117 cases . . 105
infrequency of consumption there 100
southern slope of the mountains in southwestern . . 22
winds prevailing in. (See Climatic Map.) 27, 78
Colorado College 48
Colorado Springs, the town and its attractions 48
Complications and conclusions. (Chapter XV.) 143
Complications of asthma 105
Compressed air, Dr. Niemeyer's views on asthma 111
Conclusions, as to stage of disease 120
as to inflammatory cases 125
as to catarrhal and tuberculous cases 125
as to necessity of prolonged residence 125, 127
as to favorable conditions and results, sustaining the rule of immunity through elevation 97
as to diathermancy influenced by elevation 68–71
as to the benefits of sunshine 72
as to increased electrical influence in high altitude . . 76
as to necessity of ventilation according to elevation . . 90
as to effects of elevation in disease 92, 93, 137
as to preference for hemorrhagic cases 136

Conclusions, as to exclusion of hemorrhagic cases with excavation 136, 137, 140
as to pneumorrhagia, with or without excavation . . 140
as to nervous symptoms 147
grouped together in a general way 149–153
Consumption, definition of 1, 2
bronchial, etc. 144
classification of as to nature of disease. (Table XIV., p. 122.) 121–125
decreasing with elevation. (Chapter XI.) 95–103
Dr. Austin Flint's cases 131, 132
fibrous 113, 145, 151
may be increased in Colorado by dense population . . 102
mortality from 2–7
not an effect of climate alone 102
Consumptives, 350 years spent by 202 in Colorado . . . 114–140
analysis as to stage of disease 117–121
both lungs affected 116, 120
inherited cases, analysis of 116
Convalescence from fevers slow in Colorado 102
Convention, asthmatic, general results 105, 106
Cordillera de los Andes Mountains 20
Cotton-wood Creek hot springs 42, 174
Cordova, Mexico 15
Cool, dry climates, adapted to phthisical patients . . . 60
favorable results of 149
Cumberland table-land, climate and altitude 14
immunity from consumption 14, 98

Davos, Switzerland, winter air cure 19
moisture in the air of 65
Day, Dr., of London, on ozone 78
Days, clear and fair. (F. Climatic Map.) 28
Days, cloudy (C). Rainy (R). Snowy (S). (See Climatic Map.) 28
Deansbury, Colorado, springs at 173
Denver, city of, its importance and attractions 48–51
an outfitting point 49, 169, 172
comparison of the moisture of the air at 64
determination of diathermancy, etc. 68, 69
records of mortality from phthisis originating in Colorado . 101
Diathermancy, differences due to elevation 69
of the air. (Chapter VIII.) 68–73
tables. (Chapters XI. and XII.) 69–71
Digestion, an imperfect guide to climate 10
Digestive powers lessened by heat of atmosphere . . . 58
influenced by improved respiration 93
Discretion on the part of the invalid necessary 161, 162
Disturnel, J., on climate at Potosi 21

Distribution, geographical, of consumption in the United States . 4
Divides, the, in Colorado 23
Domingo, new town in Animas Valley 174
Dry climates, very 12, 13, 59, 175
Dry, sandy soil, temperature influenced by 54

Eaux Bonnes, a French Pyrenean resort 17
Education. (See Table of General References.) 177
Egypt and Syria, relatively *dry* climates 12, 59
Elbert, Iron Springs of 45
Electricity, atmospheric. (Chapter IX.) 75–76
positive character of, in dry air 74
Elevation, difference in for one degree of diathermancy . . 70, 71
a remedy additional to others 151
as affecting the pulse 83
as affecting respiration 81, 84
desirable if not contra-indicated 151
gradual rise for some hemorrhagic cases 142
Elimination of waste tissue 158
Emigration to Colorado. (Table of References.) 177, 178
Emotional states, influence in developing disease 155
Emphysema, mistaken for asthma 105
of the lungs, climatic influence in 111–113
complicating asthma and phthisis 113
Endosmosis of oxygen 57, 59, 90, 93
Engadine, Lower, resorts of 17
Upper, resorts of 18, 19
Equality of temperature, how influenced by elevation. (See Table VII.) 55
conclusion in regard to 149
Estes Park, chalybeate springs at 36
Estimates for camping parties 169–171
one month's provisions for one person 169–170
European climates, experience in 8, 9
resorts of medium elevations 16
Examination chart . . . . . See Preface to 2d Edition.
Exercise, prolonged or violent, influence on pulse 83
versus inaction. (Jourdanet.) 157
Exercises for use by consumptives with caution 156
should be continuous 157
Experience of life insurance companies 4–7
of consumptives in Colorado, etc. 114
Expiration influenced by elevation 84, 92
Extension of western railroads 172

Fairplay, Colorado 38
Favorable cases, pulse, respiration, and temperature of . . . 128
Females, consumption in. (Table XIII., p. 119.) 117

Fibrous phthisis complicating asthma 113
Flint, Prof. Austin, Sr., on arrested phthisis 131, 132
Florida, for consumptives "with feeble stomachs" 10, 13
Flowers of Colorado 165
Force of wind diminished in high altitudes 79
Fort Bayard 22
Fort Yuma, California, dry climate of 13
France, south of 9
Frequency of respirations 82–84
Friendships of fellow-campers 167

Geddings, Dr. W. H. 13
General conclusions grouped together 149–153
Glaisher's balloon ascensions 53
Glaisher's Table showing weight of vapor 21
Gleitsmann, Dr. W. 14
Grand Cañon of the Arkansas 41
Grand Lake 34
Görbersdorf, climate of 16
Gouty diathesis, etc. 149
Gunnison City 173
Gymnastics, pulmonary 154–157

Hammond, Surg. J. F., infrequence of phthisis in New Mexico . 98
Hartzell's Hot Sulphur Spring, South Park 38
Hay fever, Dr. George M. Beard's researches 106
Haywood Springs, Hortense 173
Health lift, and similar means of exercise 156
Heat, injurious influences of; opposed to stimulation; lessens respirations, etc. 57
lessens digestive powers 10, 58
Hemorrhage and hæmoptisis. (Chapter XIV., Table XVI.) . 134–142
Hemorrhage before and after coming to Colorado. (Table XVI.) 135, 137
Hemorrhagic cases with and without softening 134
High altitudes, attributes of climate of. (Chapter VI.) . . . 52
climates of. (Chapter III.) 18
effects of, influenced by age 130
effects upon hemorrhagic cases 136–140
generally inadvisable after fifty-five years 131
how to observe caution in sending invalids to . Preface to 2d Ed.
physiological effects on man 82
their favorable and unfavorable influences 151
when the approach should be gradual 152
Himalaya Mountains, plateaus near 19
Horses and ponies for camping parties 166, 168
Horseback, parties going into the mountains on 168
Hot Sulphur Springs, Middle Park. (See Table VI.) . . 30, 34

House-rents, etc. (See Table of References.) 177, 178
Humidity, chapter on 60–67
Humidity, relative and real 61
relative, corrected for elevation 63
absolute. (See Climatic Map.) 64, 65
Hypsometrical belts. (See Climatic Map.) 26

Idaho Springs and town. (See Table VI.) 30, 34
Ideal climate, for asthmatics 103
for phthisical patients 52
in general . . . . . Preface, 52
localization of 150
Inflammatory phthisis. (See Table XIV., p. 122.) . . . 122, 125
Immunity, approximate, due to elevation 95
altitude of approximate, in Colorado 160
line of, decreases in elevation towards the poles . . . 96
Inhalation combined with gymnastic exercises 155, 157
Inheritance, classification as to 116
Inland position, influence on temperature 54
Inspiration and expiration as affected by rarefaction . . . 110
Insurance, experience of life insurance companies 3
Introduction 1
Iron Springs of Elbert 45
Iron Lake (near Silverton) 45
Iron Ute Spring. (See Table VI.) 33, 39
Irrigation a necessity in Colorado 159
Irwin, Dr., on infrequence of phthisis in Arizona 99

Jacksonville, Fla., moisture in the air at, etc. 64, 65
Jalapa, Mexico 16
Jourdanet, Dr. D., Mexican experiences of 21
influence of rarefaction on respiration 84–87
recurrence of phthisis by return to low level . . 126, 127
altitude of immunity 99
on phthisis in Mexico 99

Kansas, western, medium altitude 15
Kirgheez Steppes 66, 96
Königswarth, Bohemia 16
Küchenmeister's rule for immunity 95

La Paz, in Bolivia 99
Las Vegas hot springs 47
Leadville 38, 173, 174
Lee, Dr. Edwin, favorable influence of variable temperature . 12
Le Presse 17
Lettsomian lectures 66, 67

Liberty Hot Springs, at Wagon Wheel Gap 42
Life insurance records of deaths by consumption 4
Light, Dr. Lombard's views of 73
Little Chief Spring. (See Table VI.) 33, 39
Little Ute Spring 31
Lombard, Dr. H. C., altitude of immunity 95
on prevalence of consumption 3
Longevity, average, how influenced by climate 7
Lower Engadine, climate of 17
Lungs, both affected 116

Madeira, moisture in air at, etc. 12, 66
Males, consumption in. (See Table XIII., p. 119.) 117
Mammoth Cave, Ky., experiment of sending consumptives there . 73
Manitou Park 40, 174
Manitou Springs, description of and surrounding attractions . 39
railroad connections 174
Map, climatic, of eastern Rocky Mountain slope 26
Marine climates 12
Mean annual temperatures 26
Mediterranean health resorts 8, 9
Medium altitudes. (Chapter II.) 14–17
Mechanical influence of rarefied air in asthma 110
Meteorological tables. (See Climatic Map.) 27, 28
Mesilla Valley, N. M., climate, etc., of 15, 175
Mexico, city of, infrequency of phthisis in 99
inviting surroundings of 21
Mexico, climates of, medium elevations in 15
Mexico (northern), winds prevailing (climatic map) 79
Middle Park, Hot Sulphur Springs 30, 34
Mineral springs and health stations 29–51, 173
tables giving analyses 30
Mining. (See Table of References.) 177, 178
Minnesota, climate of 14
cases of arrested phthisis there 132
Moist climates, unadvisability of 65, 66
Moisture, weight of, in air. (See "G. V.," Climatic Map.) . . 28
Mont Doré, France, climate of 16
Montana, the, in Peru 20
Morrison Springs, Evergreen House (now called "Swiss Cottage") 37, 173
Mortality from consumption originating in Colorado 101
Mountains, protection afforded by 54
Mount Bross, Col., determination of diathermancy . . . 69, 70
Mount Lincoln, Col., peaks seen from summit of 38
Movement of wind, total monthly. (T. M., Climatic Map.) . . 28
Mutual Life Insurance Company, experience of 4–7

Nasal catarrh, effect of climate of Colorado upon 176
National Life Insurance Company, experience of 4
Nature of disease, analysis as to. (Table XIV., p. 122.) . . 121–125
Navajoe Spring. (See Table VI.) 31, 39
Negative and positive electricity in the ground and air . . . 74
Nerves easily overtaxed and refreshed in elevated sections . 148, 149
Nervous derangements 145
symptoms, if acute they are aggravated 147
system, complications, etc. 147, 148
Neuralgia, muscular rheumatism 149
New Mexico, dry climate of 21, 22
infrequence of consumption there 98
medium altitudes in 15
New Orleans, determination of vapor in the air 64
New York city, ratio of deaths by consumption. (Tables IV., V.) . 6, 7
Niemeyer, Dr. Felix von, prevalence of consumption . . . 3
compressed air in asthma 111
use of alkaline muriatic springs 29
Night air, comparatively harmless on western plains . . . 164

Ojo Caliente, N. M., hot sulphur springs 46
Orizaba, Mexico 15
Ouray Mineral Springs 45
Out-door life 75, 90
essential, conclusion 152
Outfitting for camping parties 166–171
Outfit for four persons, — tents, blankets, etc. 171
Oxygen, possible overplus of 91
condensed, effects of on life, ... 89
endosmose of 85, 90, 93
Oxygen, amount absorbed, how affected by temperature . . 58
amount absorbed, how affected by exercise 59
deficiency of, due to elevation 86, 87
irrespirable, an overplus 87, 89, 91
residual, "tension of," etc. 88, 89
Oxygenation of blood 90, 91
Ozone, relation of electricity to, tests for, etc. 76–78

Pacific coast climate, moisture of the air there 56
slope. (See Medium Altitudes.) 127
Pagosa Springs, San Juan Mts., etc. 22, 43, 175
Parks, elevated, in Colorado 24
Parlin, Dr. A. L., U. S. A., "Notes on New Mexico" . . . 15
Parnassus Springs, muriatic alkaline 32, 48
Pau, type of a *sedative* climate 11
Percentages of results from climatic treatment. (See Tables XIII.–XVI.) 117–137

Peruvian Andes, phthisis unknown in 99
Peru, the Montana in 20
Phthisis, definition of 1, 2
complicating emphysema and asthma 113
fibrous 113, 144, 151
hemorrhagic cases. (See Table XVI.) 134–142
large number of cases arrested in Rocky Mountain section . 133
Physicians in Colorado, testimony of, as to infrequency of consumption originating there 100
"Pine Forests of Georgia," by Dr. Ezra R. Pulling . . . 13
Pinkerton's alkaline spring 45
Pisa, loss of prestige 11
Plains and elevated basins in the United States 22
Pleurisy 145
Pneumonia, acute, etc.; frequency of 97
Pollock, Dr. J. E., subdivision of phthisis into stages . . . 115
classification as to age 128
cases with both lungs affected 116
tonic and invigorating climate for consumptives . . . 133
Population, if dense, disease is engendered 159
Porter Spring, North Denver 30, 51
Positive features of high altitudes 52
Post-mortem examinations hardly verify previous classifications . 121
Potosi in Bolivia 21
Precautionary measures. (Chapter XVI.) 154–160
Pressure, atmospheric, on human body 81, 150
how it influences respiration 110
Prevalence of consumption 2
Prevention of consumption 158
Profundity of respirations 84
Prolongation of life for the consumptively inclined 159
Provisions, estimates for one person for one month . . 169, 170
Pueblo, town and surroundings 47
Pulmonary gymnastics 154–157
hemorrhage. (Chapter XIV., Table XVI.) . . . 134–142
Pulse, favorable and unfavorable 94
increase of, due to elevation 82
Puncha Springs 41, 174–176

"Queen City of the Plains" 48
Quito, elevated plain of 20

Railroads, headquarters of. (See Table of References.) . . 177–178
to and in Colorado 171, 172
Rainfall in inches. ("R. F.," Climatic Map) 28
Rain gauge lines. (See Climatic Map.) 27
Ranche and River Springs, Estes Park. (See Table VI.) . 30, 36

Ranche life favorable for consumptives 159
Ranges of temperature, monthly, daily, etc. (Table VII.) . . . 55
Rarefaction, how it checks hemorrhage 139
of confined air, influence on life of birds 87–89
of the air due to elevation 63
Ratio of deaths by consumption 2, 5, 7, 96
Rattray, Dr. A. 57
Records of cases of consumption in Colorado 114–126
Recurrence of asthma on return to low level 109
Reed Jr., Dr. Jacob, analysis of hemorrhagic cases . . . 138, 139
Reference, Table of General 177, 178
Relative humidity (R. H., Climatic Map) 28, 61–66
Residence in high altitudes to be prolonged in certain cases . 126, 153
Respiration, character of, in asthma 110
how influenced by sadness, etc. 155
influenced by elevation 81–84
influenced by heat of atmosphere 57
"Respiratory diet" of Jourdanet 86
Respiratory surface in man 81
Results of climatic treatment of consumption in Colorado. (Chap. XIII.). 114–126
as to stage of disease. 117
Rheumatism, chronic 149
Rocky Mountains in Colorado 24
base, dry climate of 54
causes of high mean annual temperature along eastern base . 54
Rome, Dr. Williams' opinion of 11
Rose, Dr. George S., rainfall and temperature at Fort Yuma . 13
"Roughing it" in camping out 164
Routes of travel for Colorado-bound tourists 171, 172

Sandwich Islands, statement of an old sea captain concerning . . 12
San Juan mining region, mineral springs of 43, 44
San Paulo, Brazil, climate of 16
San Diego, California 13, 127
Santa Fé, climate and surroundings of 47, 175
Santa Barbara, California 13
moisture in air at 64, 65
Scenery in Colorado 24
Schönbein's an imperfect test for ozone 77
Schreiber, Dr. J., opposite views as to climate 53, 59
Scotland, experience of ten life assurance companies in. (Table V.) 7
Sedative climates 11
Seltzer Spring, at Springdale, Colo. 30, 35
Sex, classification as to. (See Table XIII., p. 119.) 117
Shoshone mineral springs. (See Table VI.) 33, 39
Siberia, rarity of phthisis in 59

Sierra Nevada and Madre Mountains 22
Signal Service Bureau. (See Climatic Map.) 60
Silver Cliff 41
Sleep, ability to sleep enhanced 149
Sleeping upon the ground 75, 165
Smith, Dr. Archibald, phthisis unknown in the Peruvian Andes . 99
Solly, Dr. S. E., on organic nervous diseases 147
South Arkansas, a new town near Puncha Springs 174
South Park, Hartzell's Hot Sulphur, and South Park Springs, in 30, 38
Spengler, Dr., on altitude of immunity 97, 98
Springs, mineral. (See Table VI.) 29–51, 173–176
Antelope 43
Bethesda, Wisconsin 31
Cañon City 40, 41
Cañon Creek 45
Carlisle 31, 48
Chalk Creek (now called Haywood Springs) . . 32, 42, 173
Cotton-wood Creek 42, 174
Elbert, Iron 45
Hartzell's 38
Idaho 30, 34
Iron Duke 30
Iron Lake 45
Las Vegas, N. M. 47
Liberty Hot, Wagon Wheel Gap 33, 42
Little Ute 30
Manitou (Iron Ute, Shoshone, Navajoe, Manitou, Ute Soda, Little Chief) 30, 33, 39, 40, 174
Middle Park Hot Sulphur 30, 39
Morrison 37
Ojo Caliente, N. M. 32, 46
Ouray 45
Pagosa 22, 33, 43, 175
Parnassus 32, 47
Porter, North Denver 30, 51
Pinkerton's 45
Puncha 41, 174
Rancho and River, at Estes Park 30, 36
Red Sulphur, West Va. 31
Saratoga 31
Seltzer or Springdale 30, 35
South Park 30, 37
St. Moritz 31
Uncompahgre 45
St. Moritz, health station 18, 85
Stages of Consumption, Dr. J. E. Pollock on 115
Stage of disease, analysis as to. (Table XIII., p. 119.) . 117–121
first, analysis of. (Table XIII., p. 119.) 117

Stage second, analysis of. (Table XIII., p. 119.) 118
third, analysis of. (Table XIII., p. 119.) 118
second in phthisis hastened by elevation 116
of softening unfavorable in hemorrhagic cases . . . 137
Stimulating climate 12
Stimulating effect of elevation 150
Stimulating resorts at low elevation 12
Stock raising. (See Table of References.) 177, 178
Summer catarrh, Dr. Beard's investigations 106
Sunlight in Colorado 163
Sunshine, benefits increase with elevation 72

Tables showing ratios of deaths by consumption 4–7
analyses of 202 cases of consumption . . 119, 122, 129, 135
analysis as to hemorrhage or hæmoptysis 135
diathermancy of the air 69–71
of mineral springs, analyses 30–33
of general references 177, 178
showing weight of vapor in cubic foot of air . . . 62, 65
showing ranges of temperature 55
Temperature, analysis of. (See Climatic Map.) 53
annual (T., climatic map) 28
influence of, upon weight of vapor in the air . . . 61, 62
of body, influenced by heat of atmosphere 57
relation to quantity of oxygen in air 58
table giving various ranges 54
"Tension of Oxygen," Paul Bert's experiments 87–89
"Timber line" 24
Tissue change, to be stimulated as it is well borne . . 151, 157
Travel, routes for Colorado-bound tourists 171, 172
Tuberculous cases, unfavorable class 120
unfavorable class, Dr. Roswell Park's views 121
phthisis, chronic, group of. (Table XIV., p. 122.) . 122–125
Twin Lakes and surroundings 39, 174
Tyndall, LL. D., John 63
Types of consumption. (Table XIV., p. 122.) 114

Uncompahgre mineral springs 45
Unfavorable cases of phthisis; pulse, respiration, temperature of . 128
University of Denver 51, 177
Upper Engadine, climate of 18
Utah, infrequence of consumption there 98
Ute Pass 40
Ute Soda Spring, Manitou. (See Table VI.) 33, 39

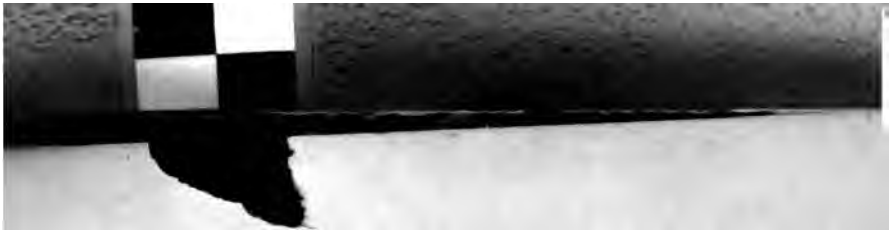
Vacher, Dr. L., Le Mont Dore-Davos 19, 82
influence of altitude on respirations 82

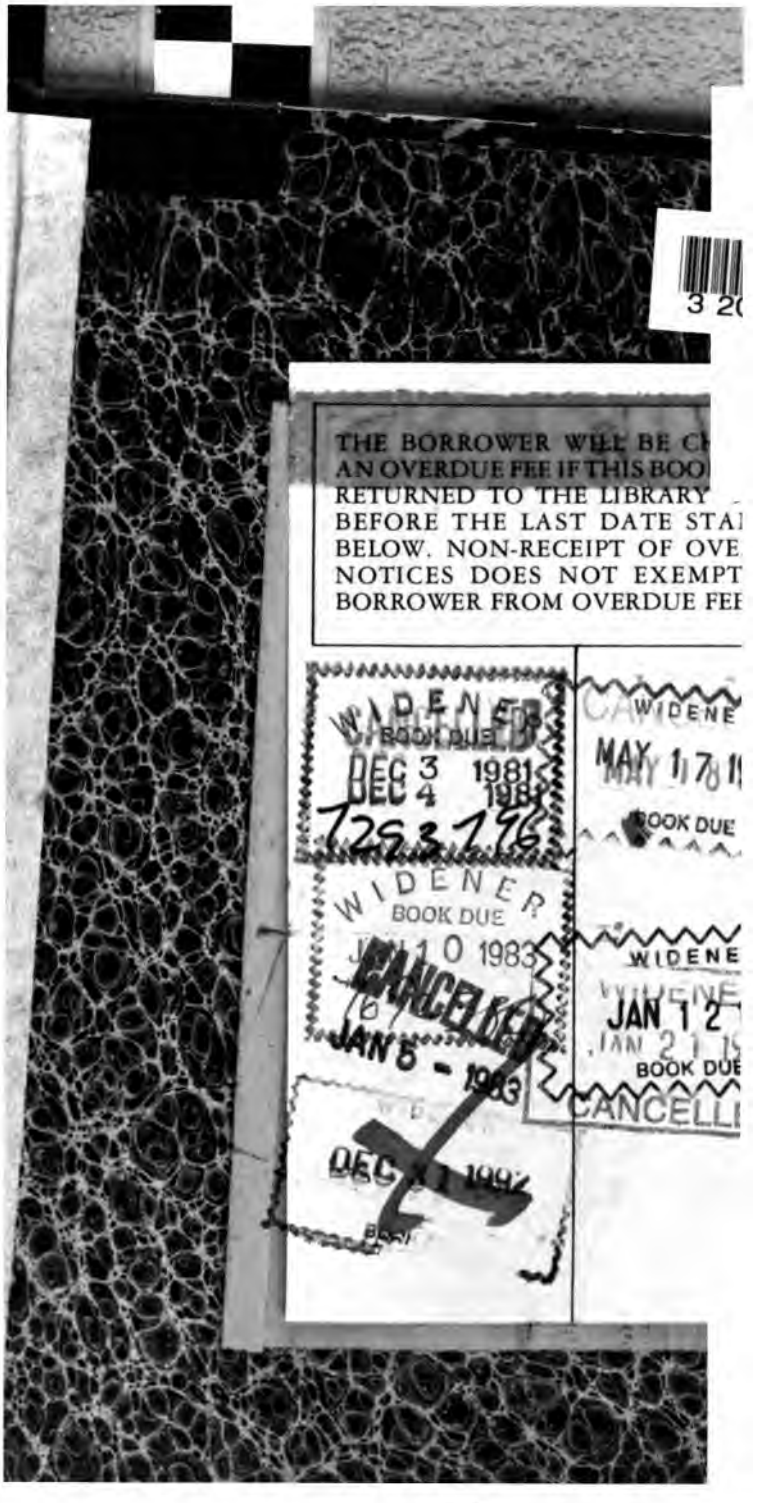
Vacher, Dr. L., on altitude of immunity 98
Valencia and Venice, types of sedative climates 11
Vapor, weight in grains per cubic foot of air. (Table VIII.) . 62, 64
Ventilation and out-door life 90
Vicarious drains, etc. 158
Vollum, Surgeon E. P., on infrequence of phthisis in Utah . . 99

Wagon Wheel Gap, hot springs at 42
Wagons for camping 167
Walden's Ridge, Cumberland Mountains, climate of . . . 14
Walker, Prof. F. A., Statistical Atlas of U. S. A. 79
Walshe, Dr. W. H., on altitude of immunity 97
on St. Moritz 18
on Valencia 11
conclusions as to climate 8
Weber, Dr. Herman, altitude of immunity 97
hemorrhagic cases sent to elevated resorts 138
inflammatory origin of phthisis 2
recurrence of phthisis by return to low level 126
Weight of air, how changed by temperature 58, 62, 63
of nitrogen and oxygen in the air at Golden, Colorado . . 63
of vapor in a cubic foot of air. (Table VIII.) . . . 62
Wet Mountain Valley, "The Briton's Paradise" 41
White Mountains, relief of asthma in 106
Wight, Dr. E. M., Cumberland Table-land 14
on altitude of immunity 98
Williams, Dr. C. T., records of continental resorts 131
altitude of immunity 97
consumptives treated in foreign climates 66
recurrence of phthisis by return to low level . . . 126
results of climatic treatment 11, 66
statistics of English health resorts 11
Winds in high altitudes 78, 79
continuous moist, Pacific winds 56
discussion, how influenced by elevation 78, 79
equatorial and Pacific, influence on temperature . . . 54
most and least "likely" to bring rain 28, 79
prevalence and direction. (See Climatic Map) . . . 27
Wyoming, Southern, winds prevailing. (See Climatic Map) . 79

Youth, an advantage in changing to high altitudes 130

Zacatecas, Mexico, infrequence of phthisis there 100

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